Spring 2017

As Above, So Below: Tapping into the Latent Energy of Abandoned Underground Infrastructure

Alexandra N. Ramirez

AS ABOVE

TAPPING INTO THE LATENT ENERGY OF ABANDONED UNDERGROUND INFRASTRUCTURE

IMAGINING CREATIVE WAYS IN WHICH THE ARCHITECT CAN FORMALIZE AN ECONOMY OF WASTED ASSETS

TO CREATE SUSTAINABLE URBAN ENVIRONMENTS AND TO RECONNECT SEGREGATED CITIES

SO BELOW

Alexandra N. Ramirez
Thesis Proposal 2017

How much surplus energy do we produce as a society?

What can be done about it?

But more specifically

What can *the architect* do about it?

CONTENTS

1

INTRODUCTION.

IDENTIFYING THE ISSUE

"How can the architect formalize the use of surplus enery to reach more people in a more systematic way?"

"What are creative ways to formalize surplus energy to benefit the layman and in turn, the greater economic and social sphere?"

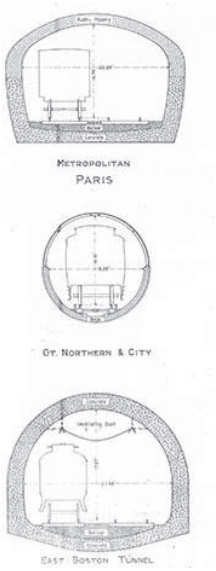
Our modern society espouses a culture in which there are a million and one ways to waste something. We have a surplus in energy that comes in many forms. Just to name a few, there is an overproduction of goods, waste heat from machines, and abandoned or underutilized infrastructure. This gross amount of surplus wouldn't be receiving so much attention if there wasn't an equal or even greater amount of shortage. The two are married, whether they are halfway across the world or within a 5 mile radius, related or unrelated, there never seems to be one without the other. In an efficient and well-oiled economy one would think that this surplus would be used to benefit someone or something, but oftentimes this is not the case. Food is thrown away, abandoned buildings are left to rot, and societies overlook assets they already have.

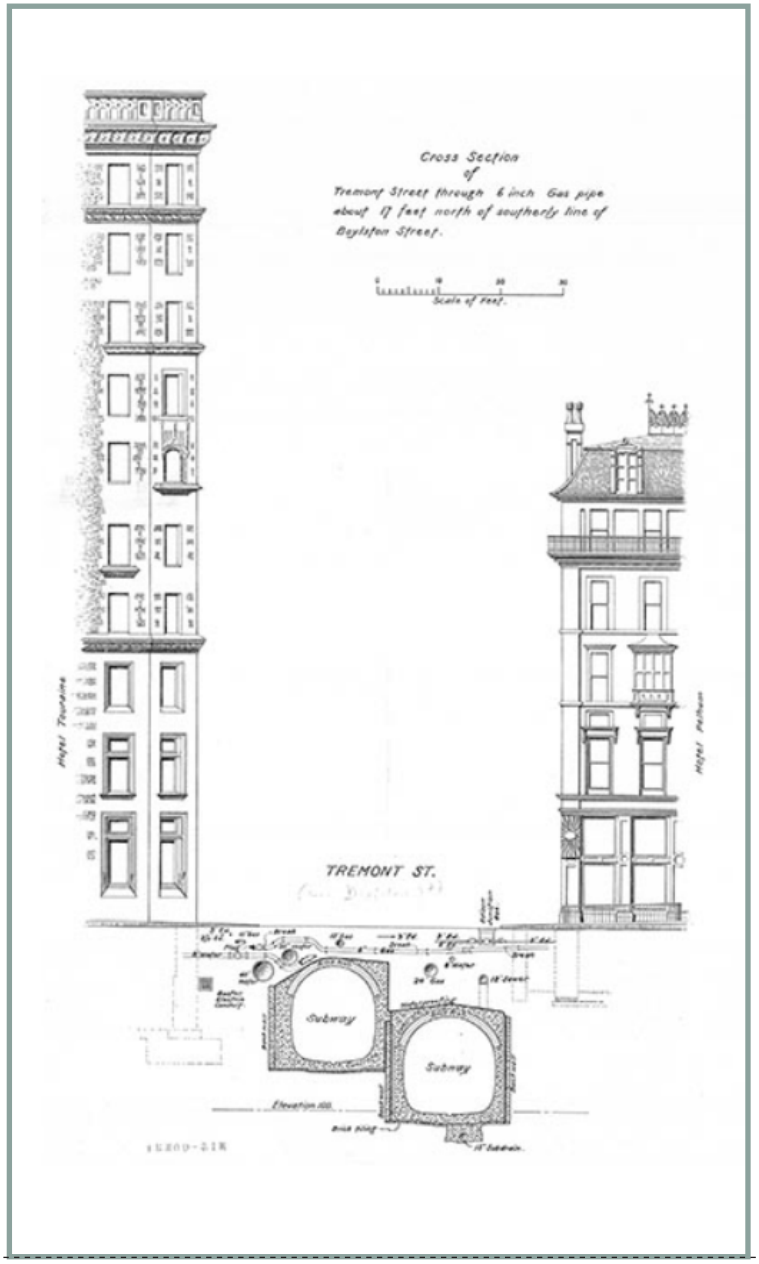
Throughout history, however unsystematically, people have found ways to dip into this bank of excess resources - for example a homeless man taking shelter within an abandoned underground tunnel, or sleeping on subway exhaust grates for warmth. Anecdotal stories of people exploiting an inefficient system scurry through conversation, but can it amount to more? How can architects formalize the use of surplus energy to reach more people in a more systematic way? This thesis tries to imagine creative ways in which the architect can redirect a type of surplus energy to benefit the layman and in turn, the greater economic and social sphere.

CONTENTION

Implications Beyond Project

This thesis will establish a framework for repurposing underground infrastructures. The strategy operates under an umbrella of sustainability and urban improvement which are two concepts applicable to sites far beyond the ones researched here.





Abandoned underground infrastructure is an example of an untapped surplus in energy that the architect has the opportunity to repurpose. Tunnels in particular, can be used as systems to heat or cool a network of buildings above ground to create more sustainable urban environments. In addition the system could also have beneficial social implications within segregated cities by providing fluid connections between divided neighborhoods.

Underground tunnels and other metro infrastructure have qualities very complimentary to an integration of passive geothermal systems. Being at least 6 ft. below the earth's surface, this infrastructure is able to take advantage of the earth's more stable temperatures.

There is an offset in seasonal temperatures due to the "thermal lag" principle which leaves the earth cooler in summer and warmer in winter.

The use of geothermal energy allows the architect another opportunity; to really design an engaging system that celebrates this form of sustainable energy typically overlooked by the public. Geothermal systems have the potential to uniquely spatialize the human experience when brought to the forefront of design. This thesis experiments with semi-tempered framing, surfaces, and programs that work with underground space to improve street life and create an atmosphere of aesthetic and temperate comfort.

2

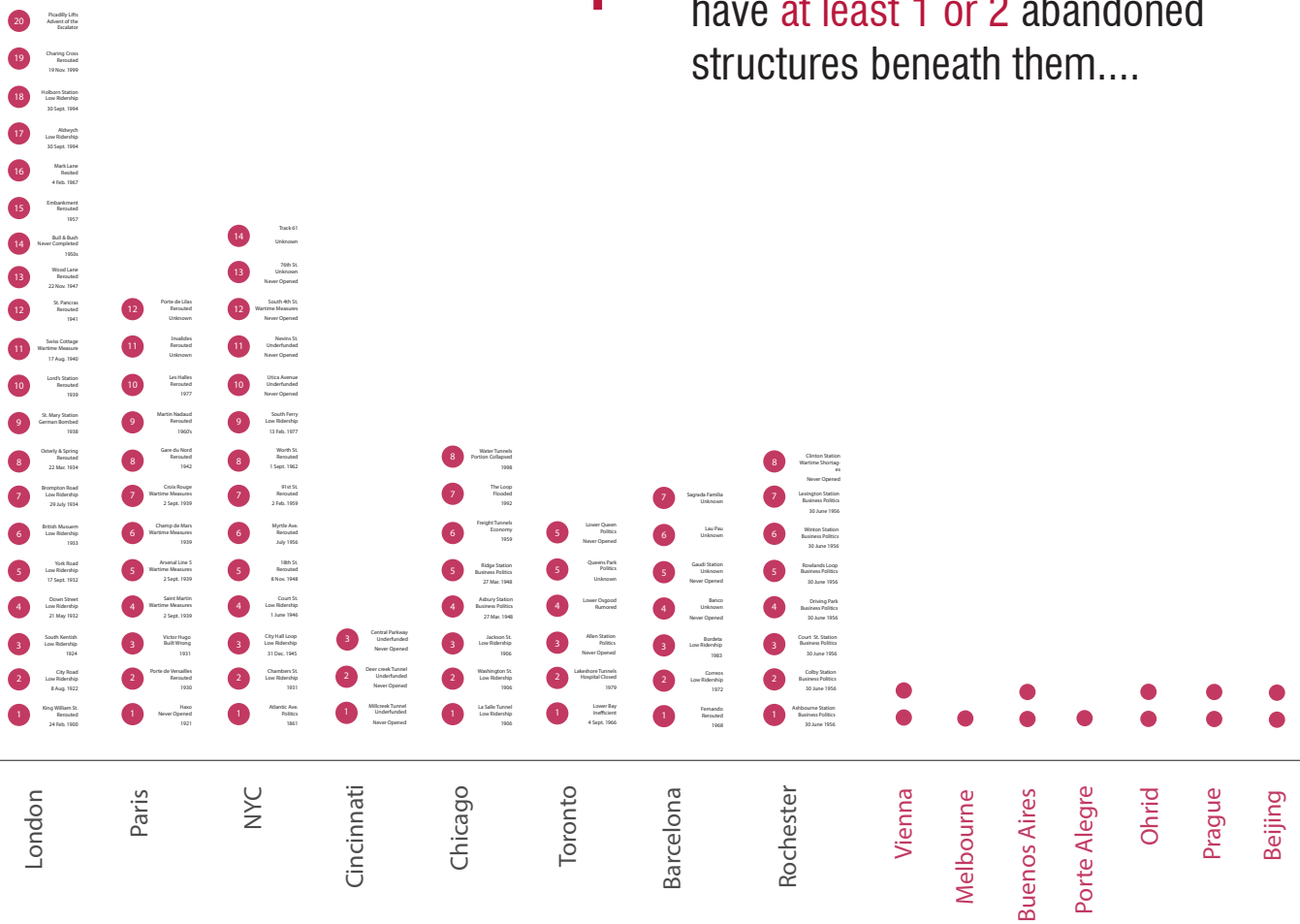
RESEARCH.

ABANDONED UNDERGROUND INFRASTRUCTURE

77 Abandoned tunnels and stations beneath 8 cities

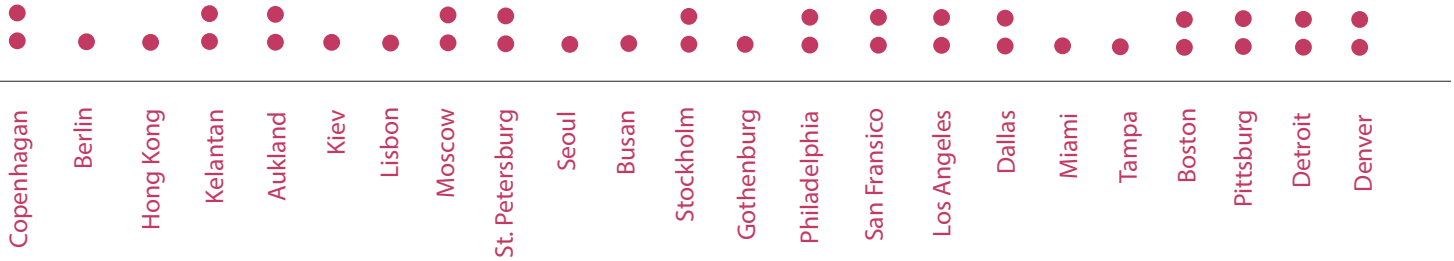
\+

Which is not including a collection of other cities that have at least 1 or 2 abandoned structures beneath them....



"It was amazing to find these huge spaces, unused and lonely. In a city where every bit of space is filled with people, it was magical to find places where I could be as alone as if I were resting upon a mountaintop -- when in reality, these places were no more than a few dozen feet below some of the busiest streets in the world."
Steve Duncan on exploring New Yorks forgotten infrastructure

Constructing beneath the earth's surface has long been an amenity to society. Whether the structures were created to carry water, utilities, or act as a mode of transportation, one would be hard-pressed to find an urban setting without infrastructure built beneath it. However, in society's constant state of evolution things that are built one year fall out of use the next. There are many reasons for infrastructure to become abandoned. The graph below documents the amount of abandoned underground tunnels and stations beneath a selection of cities and captions the year and the reason each one fell into abandonment. It is interesting to find that several tunnels never even opened, either due to lack of funds, wartime measures, or politics. In any case the amount of underutilized underground infrastructure that the majority of people don't even know about present unique design opportunities for architects.



2.

1.

6. Central Pkwy tunnel
Cincinnati, Ohio

5. Edgewater Tunnel
New Jersey

4. Abandoned metro
Buenos Aires

3. Atlantic Ave Tunnel
Brooklyn, N.Y.

2. Metro Saint Martin
Paris, France

1. Down Street Station
London, UK

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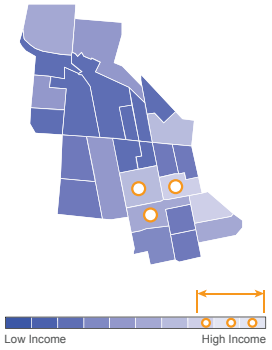
OPPORTUNITES PRESENTED

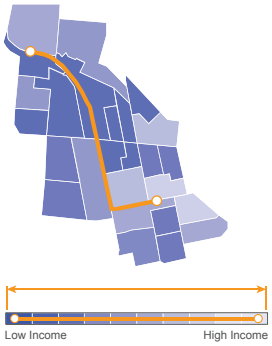
COUNTY CONNECTION

THE NODE
(Static Destination)



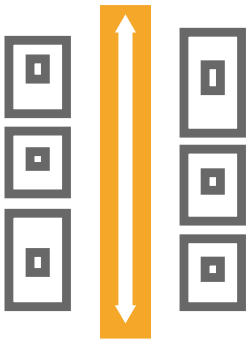
VS

THE LINE
(Dynamic Link)



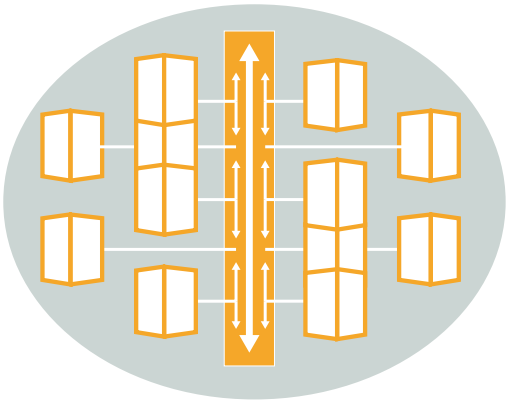
AFFORDABILITY

DISCONNECTED
LOCAL FABRIC



VS

INTEGRATED
LOCAL FABRIC



Underground tunnels possess qualities that present designers with unique opportunities to exact social and economic change within urban communities. In addition to providing easy access to geothermal energy, tunnels are also able to connect segregated neighborhoods by providing a common link of affordabie living between them. There is a comparison that can be made that is as simple as comparing the line versus the node. In this comparison the node represents monuments, presitigious buildings, or any other kind of destination point. The line represents the underground tunnel. The diagram to the left illustrates city county lines and color codes them according to average income. As you can see the “nodes” symbolizing monuments and buildings, are typically placed within the more affluent areas, furthering the viability of that neighborhood and widening the economic and social gap between that county and those bordering it. The tunnel on the other hand is much more elongated than the node and thus traverses a greater area through a variety of counties. By designing a space that is not just a destination but a procession, architects can provide greater effects to a greater number of neighborhoods. The economic and social inequalities that divide communities can be broken down. A high-rise 5 star hotel could be connected to a soup kitchen. The brownstone of a city official could be connected to the apartment of a blue collar worker. Everyone shares this common system of surplus energy that benefits not only their own lives but also the life of their city.

PRECEDENTS

SUBTROPOLIS | Kansas City, Missouri

A 55,000 sf manmade cave originally excavated to mine limestone is now the world largest underground business complex. SubTropolis is, in places 160 feet beneath the surface. It has a grid of 16 ft high, 40 ft wide tunnels separated by 25 ft square limestone pillars created by the room and pillar method of hard rock mining. The complex contains almost 7 miles of illuminated, paved roads and several miles of railroad track. About 3.2 acres of available space are added each year as active mining continues. Businesses who lease space in the complex will save up to 70% in utility bills.

IRON MOUNTAIN | Boyers, P.A.

A wholesale data center and colocation operations complex that supports deployments with consumption based power pricing and the ability to secure low electrical rates on a long-term basis. Optimal power usage is achieved through geothermal cooling (ambient underground temperatures in the mid-50's) and an aquifer that uses 100% recycled chilled water for reduced environmental impact. Iron Mountain's low PUE rating enables public sector organizations complying with the Ferderal Data Center Consolidation Initiative to meet the Department of Energy's Executive Order for new data centers.

ZOLLVEREIN | Essen, Germany

This school of management and design sits atop the mineshafts of an old colliery which plays a central role in the thermal strategy of the building. When the colliery was closed it's 1,000 meter-deep mine shafts were left and filled with water. The building's energy strategist saw thermal value in what was essentially wastewater and recognized it as a source of free energy for the new construction. A heat exchanger extracts heat energy from the shaft water which is then pumped to the school and cycled through its thermally active surfaces. This reduces energy consumption by 75 percent.

SALT MINES | Turda, Romania

A historical salt mine was turned into a tourist destination featuring a museum for adults and an amusement park for kids. The theme park has been visitied by over 2.5 million people since its opening and is now ranked amoung the world's most spectacular destinations. Visitors to the theme park are transported 400 meters underground aboard the same elevator shafts that were used to brind excavated salt to the surface over a century ago. The park includes a giant Ferris Wheel, a mini golf course, tennis court, an ampitheater, and an underground lake that can be navigated using paddle boats.

THE LOWLINE | New York, New York

A proposal for an underground park in Manhattan that would be located in the former Williamsburg Bridge Trolley Terminal. Co-gounders James Ramsey and Dan Barasch have suggested natural light would be directed below using a system of "remote skylights" providing an area in which trees and grass could be grown beneath city streets. This solar technology would collect sunlight through a glass shielf and transmit it onto a reflective surface that would distribute the rays underground.

BRUNEL TUNNEL | London, U.K.

A subterranean shaft designed as an entrance to London's Thames Tunnel has been transformed into an underground venue for music performers, theater, and events. Its former entrance - a small hole leading down to a now removed staircase - has been replaced with a new opening, leading through to a contemporary red accented steel staircase that descends from the surface. The designers wanted to preserve the integrity of the original structure as much as possible so the rough walls were left exposed and relatively untouched.

PRECEDENTS | design priorities

6. Salt Mines
5. The Lowline
4. Brunel Tunnel
3. SubTropolis
2. Iron Mountain
1. Zollverein School

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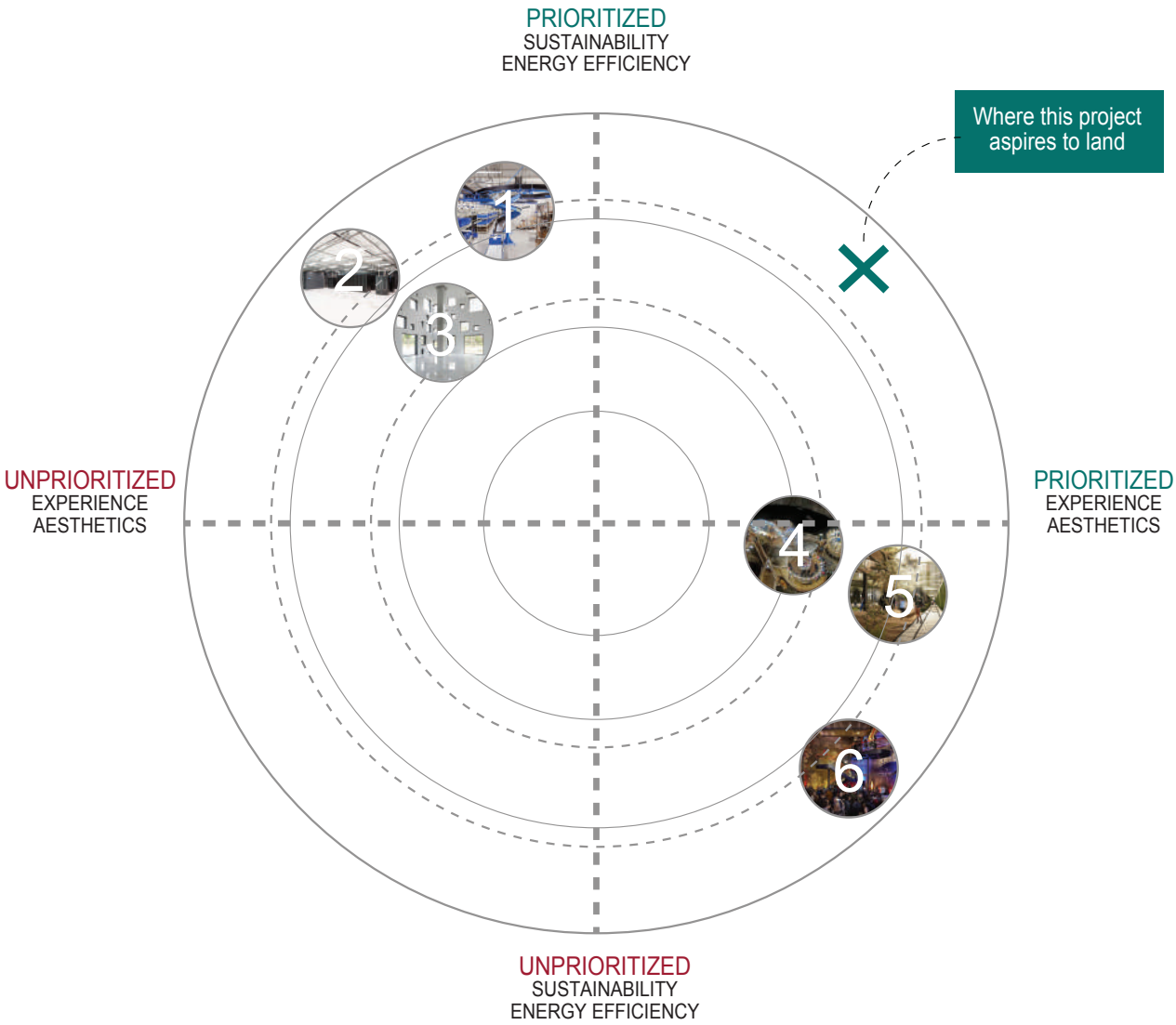
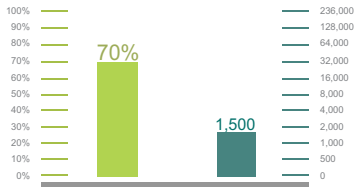
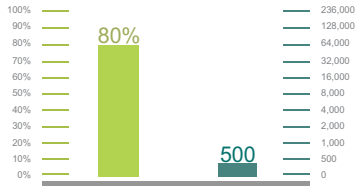
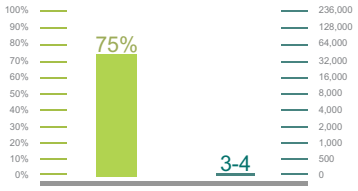
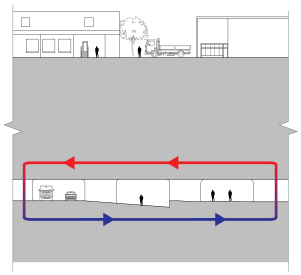

PRIORITIZED
SUSTAINABILITY
ENERGY EFFICIENCY
Where this project aspires to land
1
2
3
UNPRIORITIZED
EXPERIENCE
AESTHETICS
PRIORITIZED
EXPERIENCE
AESTHETICS
4
5
6
UNPRIORITIZED
SUSTAINABILITY
ENERGY EFFICIENCY

PRECEDENTS | energy savings vs occupancy

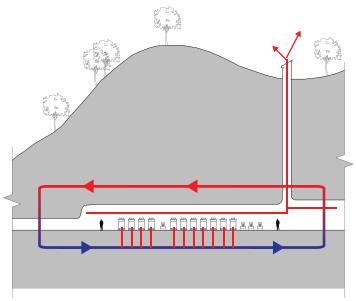




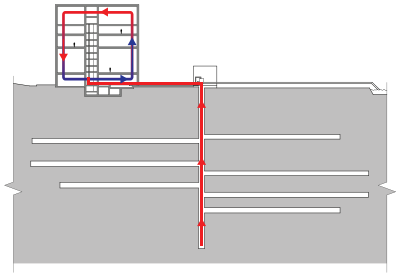




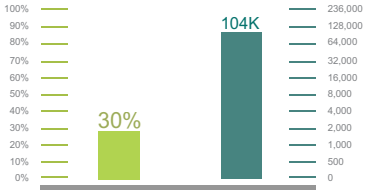
SubTropolis

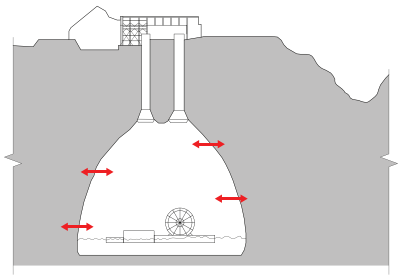


Iron Mountain

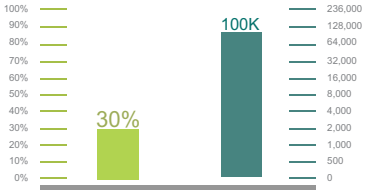


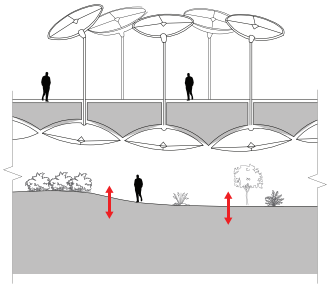
Zollverein School



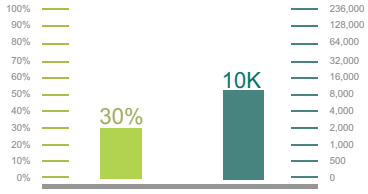


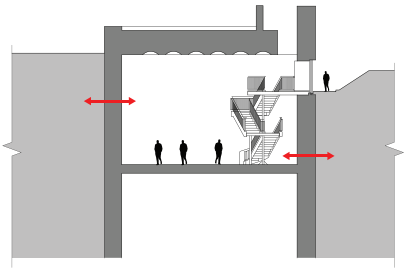
Salt Mines





The Lowline





Brunel Tunnel

CONVERSATION | Ian Shapiro

"Ian Shapiro has led several applied energy conservation reserach projects, has led many design and energy projects, and has delivered workshops in the area of energy and ventilation. He has also led the development of several computer programs which are used in HVAC, energy, and indoor air quality fields, including TREAT (Targeted Residential Energy Analysis Tools), which was awarded the 2005 national R&D100 Award. He also developed innovative desiccant cooling system, for which he holds a U.S. patent. He is the co-author of Green Building Illustrated (2014)."

-Taitem Engineering

Monday, Oct. 3rd 6:17 p.m.

I contacted Mr. Shapiro to ensure the feasibility of the project and understand how a potential passive thermal system might work with an abandoned underground tunnel.

Alex: Hello Mr. Shapiro thank you so much for taking the time to speak with me. In my email I explained the nature of the thesis project, so from what you've read do you think that it is feasible?

Shapiro: I am happy to help and yes I do think that the project is feasible. It is a very interesting concept to reuse an underground tunnel. It could act as a complementary energy source to existing mechanical systems.

Alex: I just have some concerns and questions that I was hoping you could answer. The chief thing that I've been worrying about is the cross section of the tunnel. It is 15'x13' is that too big to facilitate proper air velocities?

Shapiro: Well actually when I think of a passive system using the earth as a heat sink as you are doing in this case, the bigger the cross section the better. This is because there is a larger amount of surface area for the air to come in contact with and exchange heat. But with that being said I think it would be beneficial for you to duct the air through the tunnel and not use the tunnel itself as the duct. You could run into all sorts of problems with air

quality if you do that.

Alex: Oh okay, so if I duct the air through, how exactly would that work? I was thinking of using wind scoops to bring outside air into the tunnel but then I'm not really sure how to then pull it through the buildings.

Shapiro: A windscoop could work. What that means is that the air would be heated or cooled by the tunnel in whatever distance and then what would happen is that it would pass through a heat exchanger underneath each building. The air could either transfer or absorb heat from the circulating medium within the building and decrease the active thermal load. A system like this would operate at an extremely high efficiency. The two things that you have to take into account though, are the existing heating/cooling systems present within each building, and also the potential humidity problem. You would probably need to install a dehumidifying element.

Alex: Okay, I see. Also I've been researching into the benefits of using air versus water as the thermal medium. I was hoping to use an air system because it manifests itself in design in much more interesting ways, but water is a much more efficient heat transfer medium. What would you reccomend?

Shapiro: Okay well the thing you have to keep in mind is that there are four different types of thermal systems: Air to air, air to water, water to water, and water to air. The first medium is the intake medium and the second in the circulating medium. So from what I've gathered so far, you are aiming to use air as the intake medium. So what you can do then is decide whether you want the circulating medium to be air, or water. Now, water is much more efficient that is true, but when you start looking at what systems already exist in the buildings, there are certain ways that each are more easily retrofitted. If a building uses a boiler, it is much easier to retrofit that system with water. If the building uses a furnace it is much easier to retrofit with air. Just be sure to keeps those things in mind.

3

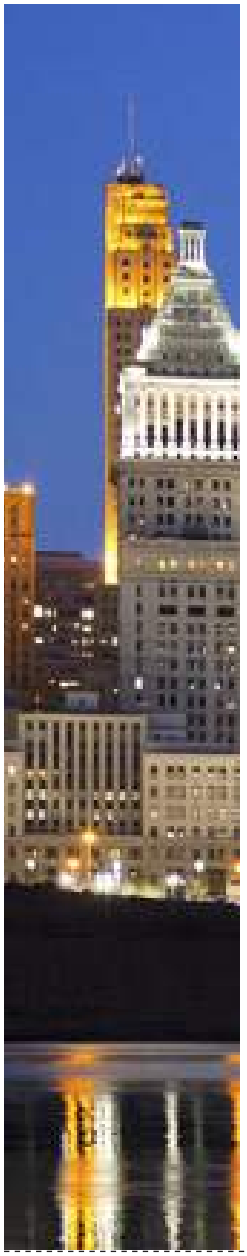
THE SITE.

CINCINNATI, OHIO

1. There is a 2 mile long tunnel running beneath a majority of the city

2. The city has a long history of segregation and income inequality

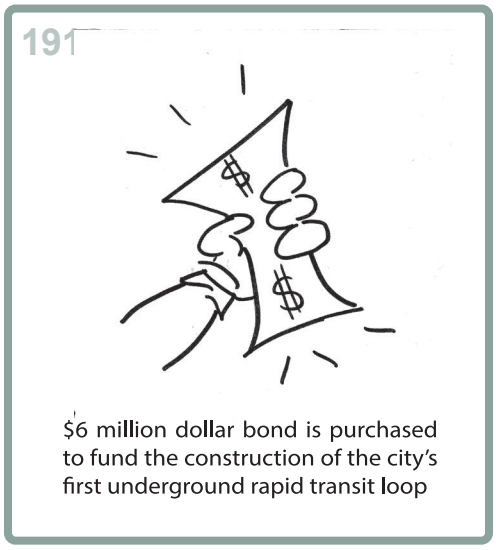
3. The city has seen rapid improvement within the past 5-10 years

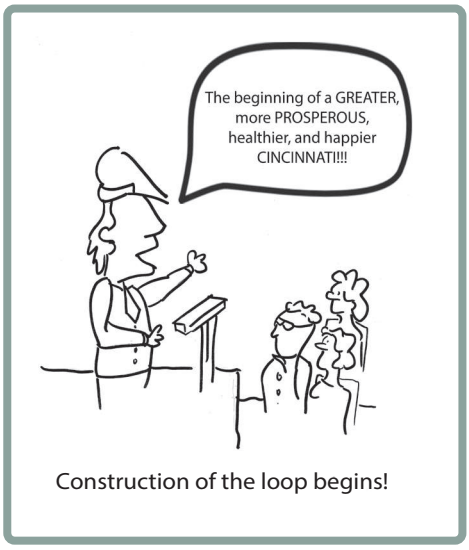


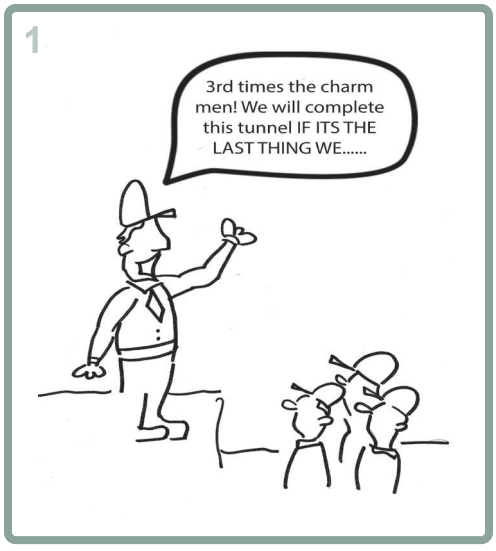
Cincinnati, Ohio is a perfect case study to experiment with repurposing underground infrastructure for three reasons. First, there is a two mile long abandoned underground tunnel that runs beneath a majority of the city. This tunnel was constructed beneath Central Parkway in phases, but was never finished due to budgeting issues. Tracks were never laid and not a single train or vehicle was ever operated inside the tunnel. Second, Cincinnati has a long history of segregation within the city. Neighborhoods are strictly divided based upon income and social standing. This condition has been exacerbated by the third reason the city has been chosen as a site, which is the rapid growth it has seen within the past 5-10 years. The downtown area has seen a boom in construction and has been largely built up. The mayor and local officials have added public amenities and parks to attract more people. They have also improved public transportation to increase public access to different areas. The mayor has just recently announced the launch of a new public street car line that runs in a loop from downtown up to Findlay Market. However the improvements to the downtown area have just widened the gap between northern and southern Cincinnati counties. The city is in need of a unifying element to ride the tide of recent urban improvement and link Cincinnati neighborhoods to create a more cohesive and stable urban environment.

TUNNEL HISTORY

Cincinnati Rapid Transit Historical Timeline







1918

WWI

Construction of the tunnel stops

1924

1929

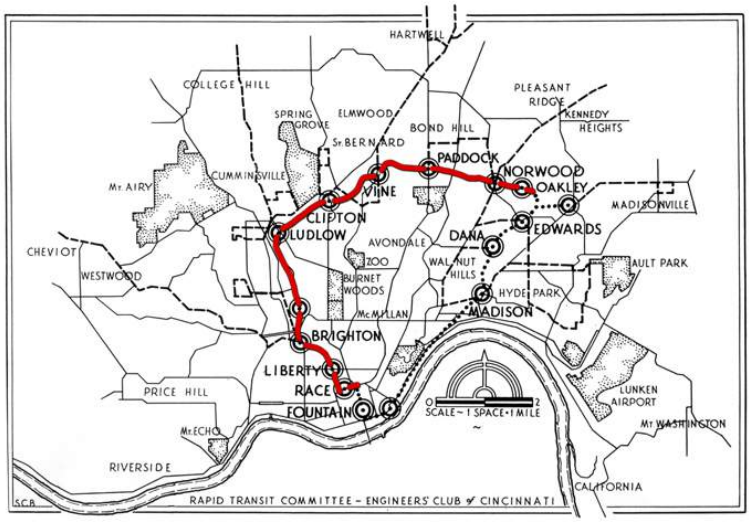
THE GREAT DEPRESSION

1939

Present

Tunnel lies abandoned for eternity

TUNNEL HISTORY



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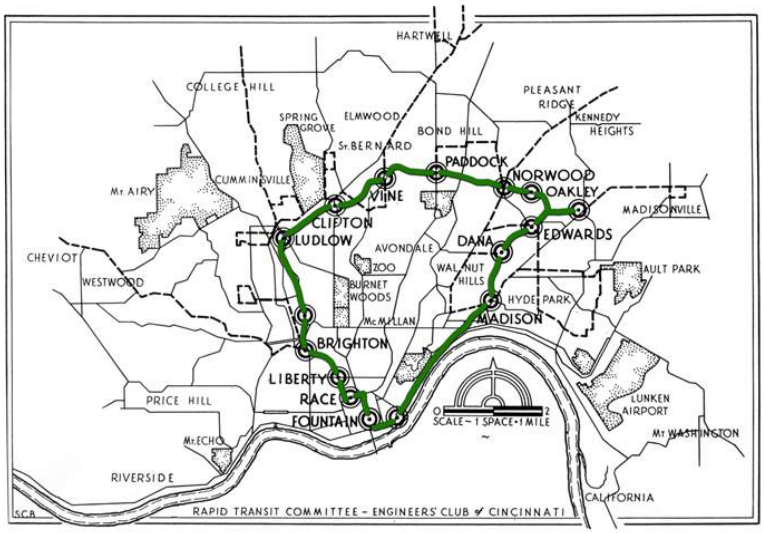


1.

6. Central Parkway 1972

5. Central Parkway 1925

4. Central Parkway 1972

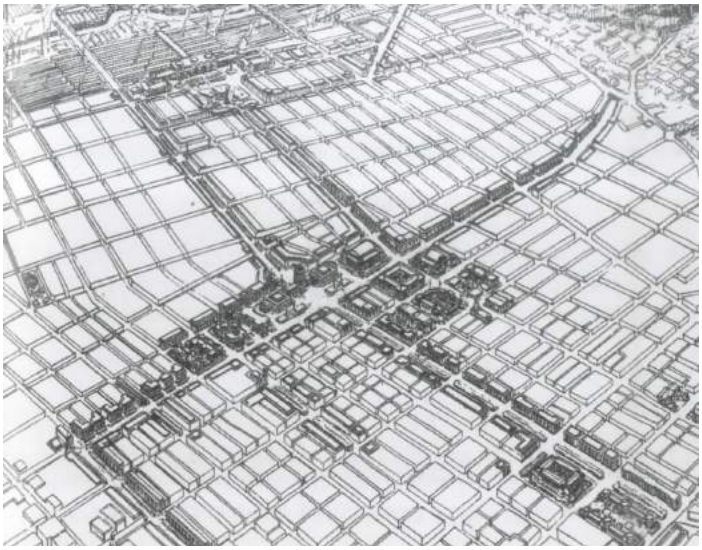
3. Drawing of planned central pkwy boulevard

2. Portion of the loop actually completed

1. Original planned rapid transit loop

4.

6.



3.

5.

TUNNEL HISTORY

7. Photo of tunnel as it exists today

6. Photo of tunnel as it exists today

5. Photo of tunnel as it exists today

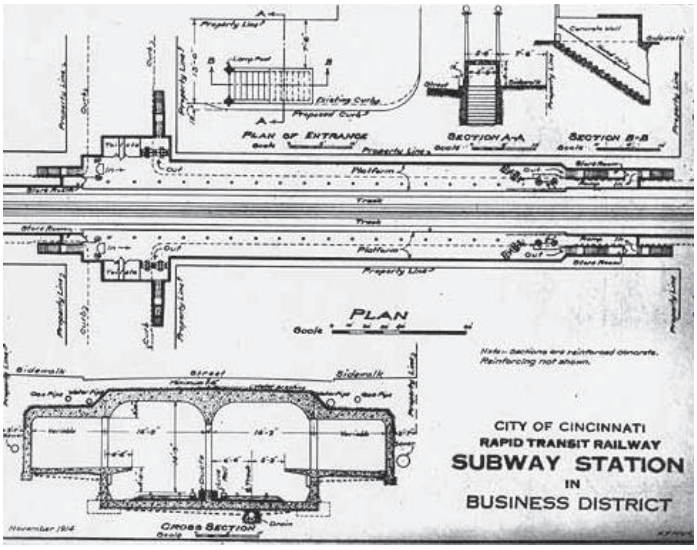
4. Photo of tunnel as it exists today

3. Cross section and plan of tunnel

2. List of tunnel phased construction

1. Site plan of Central Parkway tunnel

1.



3.

MILES	MIN.	SEC.		STATION		MIN.	SEC.	MILES
.00	0	0	GOING WEST FROM CANAL	CANAL	GOING EAST FROM CANAL	39	00	15.56
.68	2	20		LIBERTY		36	37	14.88
1.68	4	55		BRIGHTON		33	59	13.88
2.76	7	39		HOPPLE		31	16	12.80
3.90	10	27		LUDLOW		28	24	11.66
4.68	12	43		CRAWFORD		26	09	10.88
5.74	15	22		MITCHELL		23	28	9.82
6.56	17	39		ST. BERNARD		21	07	9.00
7.70	20	33		PADDACK		18	16	7.86
8.94	23	28		MONTGOMERY		15	23	6.62
9.50	25	26		FOREST		13	23	6.06
10.35	27	47		OAKLEY		11	02	5.21
11.06	29	59		DANA		8	57	4.50
12.17	32	49		MADISON		6	13	3.39
15.56	39	00		CANAL		0	0	.00

2.

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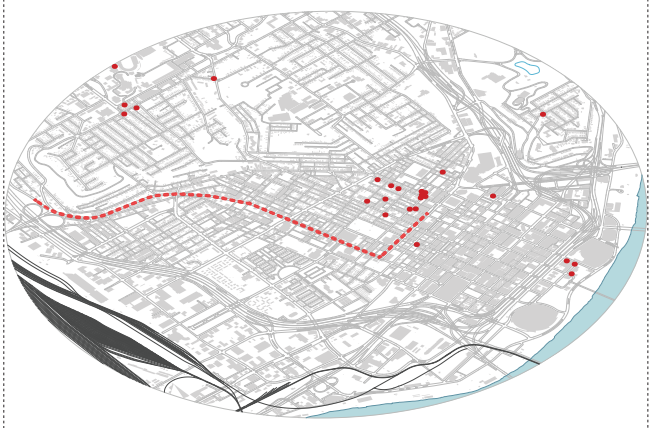
6.

SITE ANALYSIS

NIGHTLIFE

- Bars / Nightclubs



WORKDAY AMENITIES

- Restaurants
- Fitness Centers
- Parks

TRAFFIC RUSH HOUR

- Fast Speeds
- Slow Speeds

TRAFFIC WEEKEND

- Fast Speeds
- Slow Speeds

SITE ANALYSIS

City bike docking

Central Pkwy bike lanes

Cincinnati streetcar

MOBILITY

- Street Car
- Route 1 Bus
- South Shuttle
- Bike Rental / Parking

Hall of Music

Washington Park

University of Cincinnati

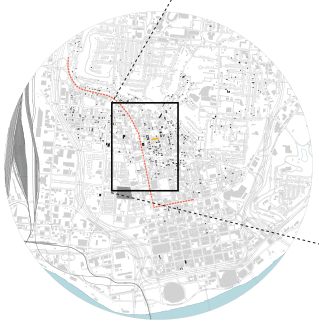
Findlay Market

TOURISM

- Shopping
- Museums / Galleries
- Monuments
- Retail District
- Key Cultural Buildings

SITE ANALYSIS

It is interesting to note that one of the most active spots in the city, Findlay Market, is largely surrounded by blocks of abandoned and vacant buildings



Findlay St. vacant buildings

Findlay St. vacant buildings

Vacant buildings

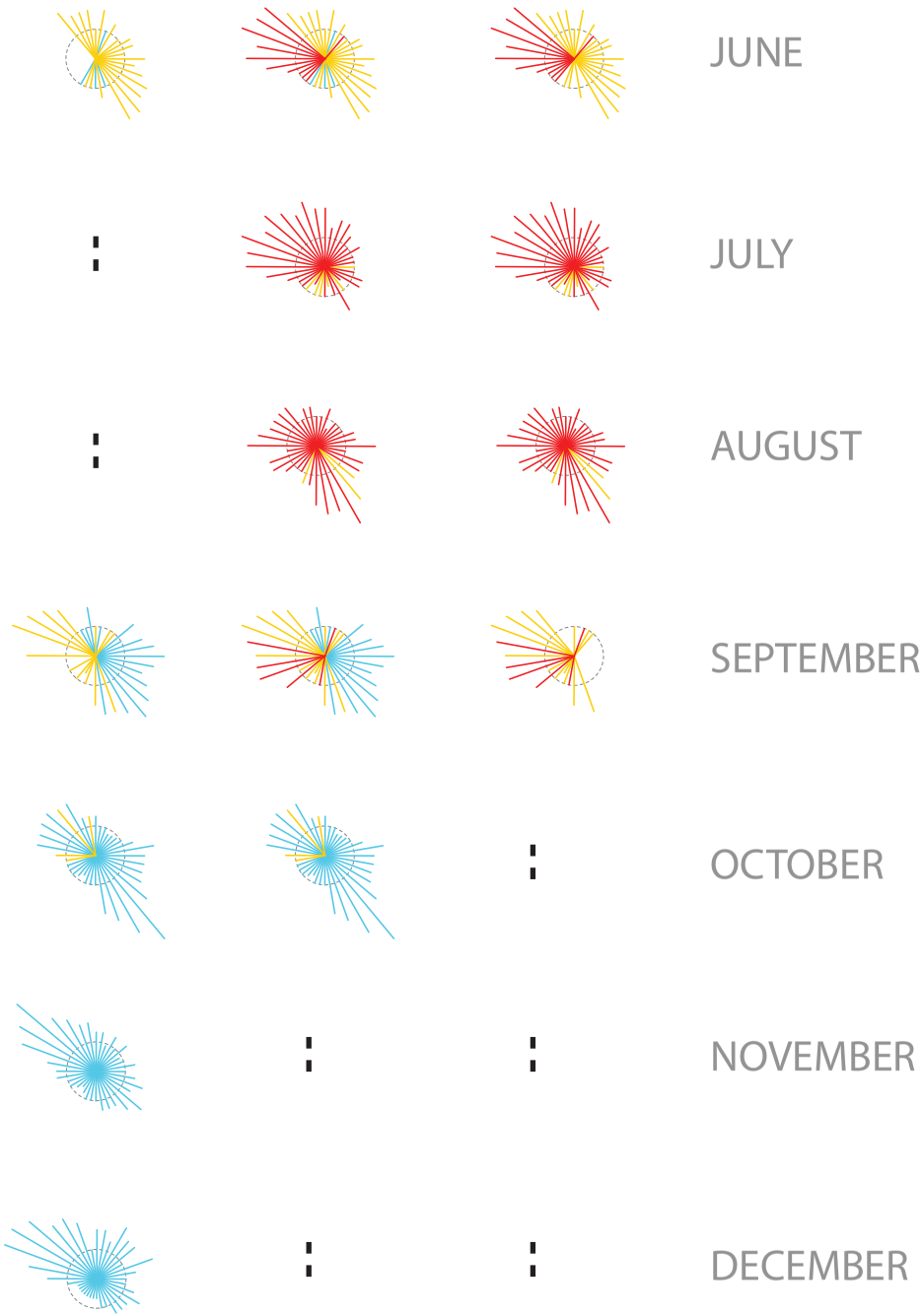
Vacant buildings

ISSUES

- Abandoned Buildings
- Brownfield

WIND ANALYSIS

	JANUARY	FEBRUARY	MARCH	APRIL	MAY
HOT <75⁰	--	--	--	--	--
MILD	--	--	--		
COLD >50⁰					


JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER

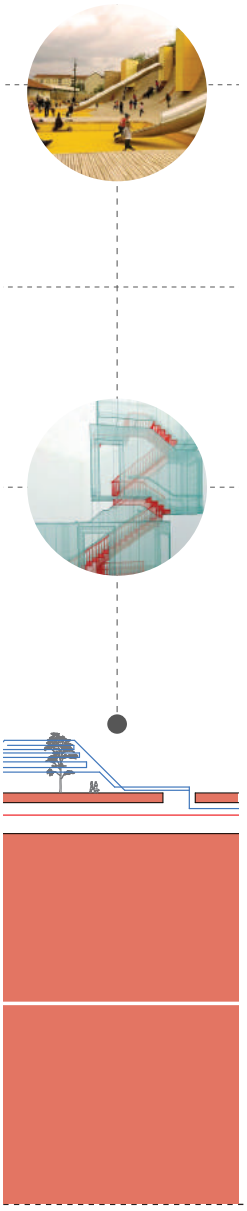
4

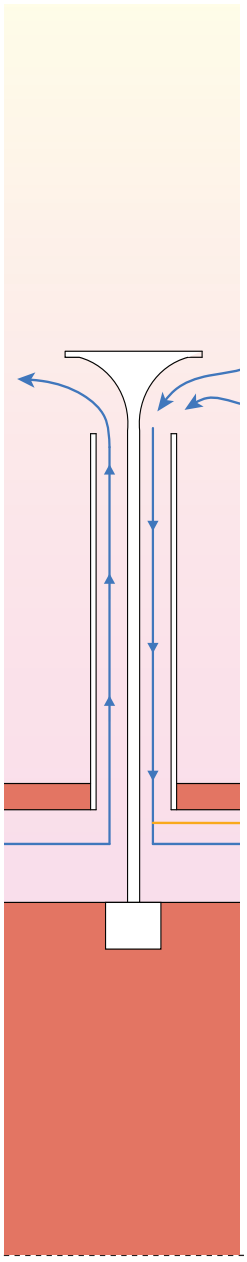
THE PROJECT.

DESIGN IDEAS

"Highly efficient spaces are still not often associated with beauty, let alone the systems themselves"

"Pedestrians are able to experience the tunnel as a relic as well as understanding it as an origin of energy"

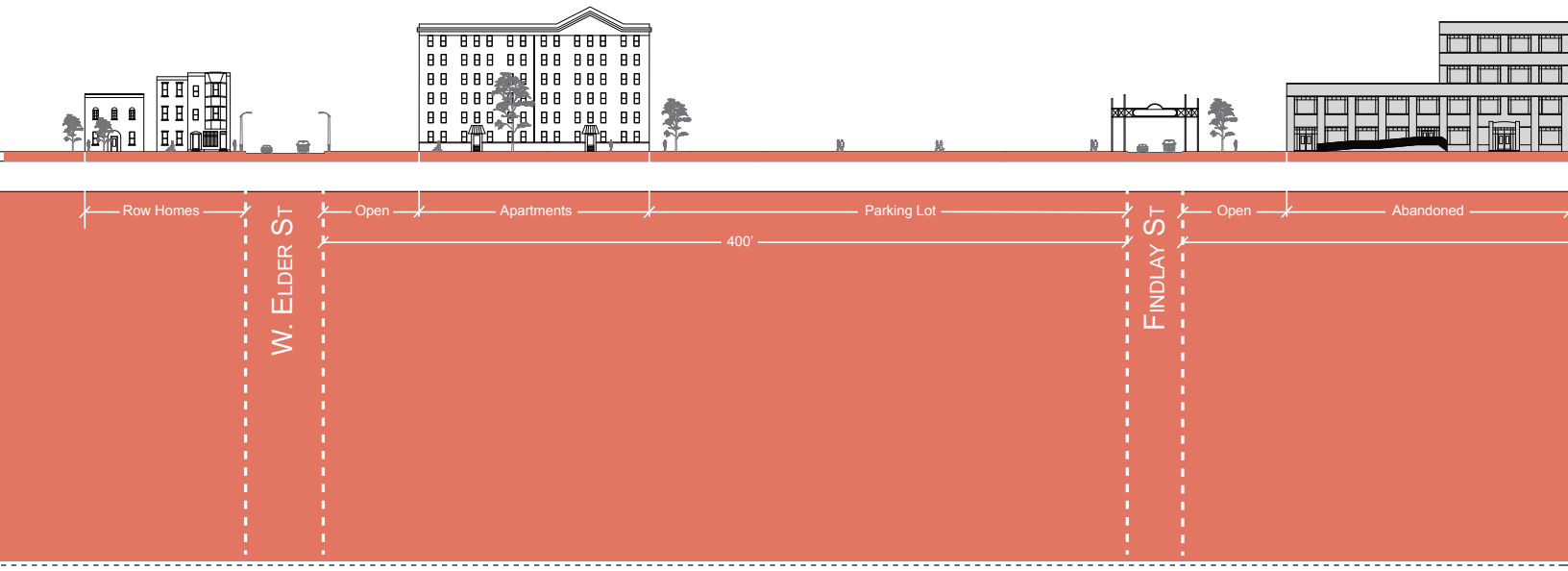




The design goals stemmed largely from the precedent analysis. Highly efficient spaces in the public eye are still not often associated with beauty, let alone the systems themselves. This thesis provided an opportunity to experiment with spatializing the geothermal system embedded within the tunnel to create moments of aesthetic and temperate comfort within the streetscape of Cincinnati. The geothermal pipes are painted vibrant colors and brought up and out of the tunnel to form lightly programmed pavilions. Tempered water runs through the floors, walls, and railings. Visitors are encouraged to engage and interact with these surfaces and frames to get a better understanding of the effects geothermal can have.

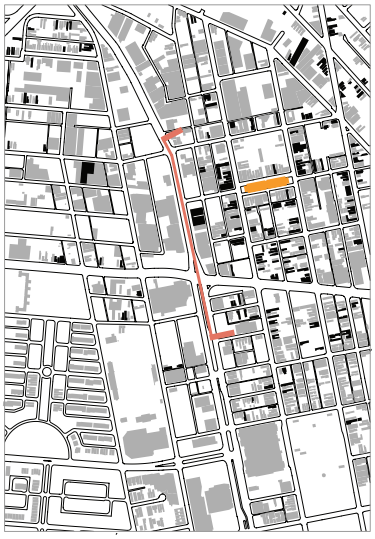
The next couple pages outline the phased design implementation. The first using the tunnel and geothermal system to supplement existing context. A windtower brings wind down into the tunnel where it goes through a heat exchanger to supplememt the HVAC systems of adjacent buildings. The second phase is adding new programs and pavilion spaces (as previously described) to infill empty lots along Central Parkway. A catwalk connects four pavilions as well as threading up and down between the street level and the tunnel level. Whilst within the tunnel, pedestrians are able to experience the tunnel as a relic as well as understanding it as an origin of energy.

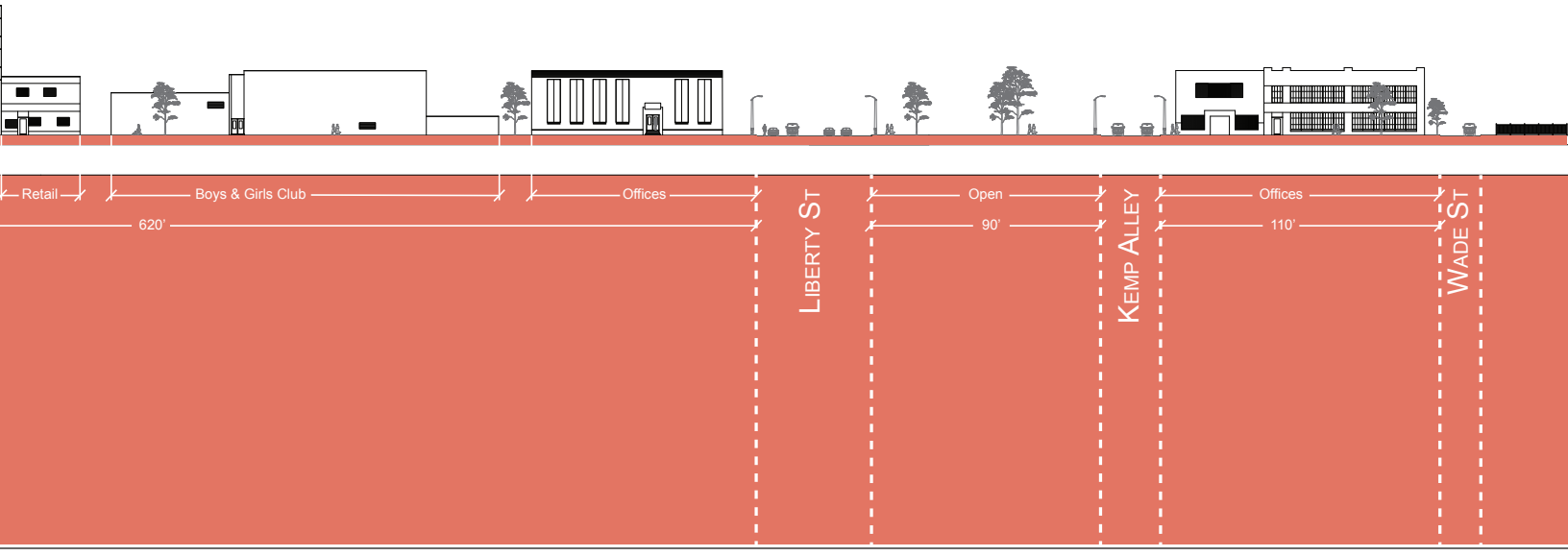
PROGRAMMING



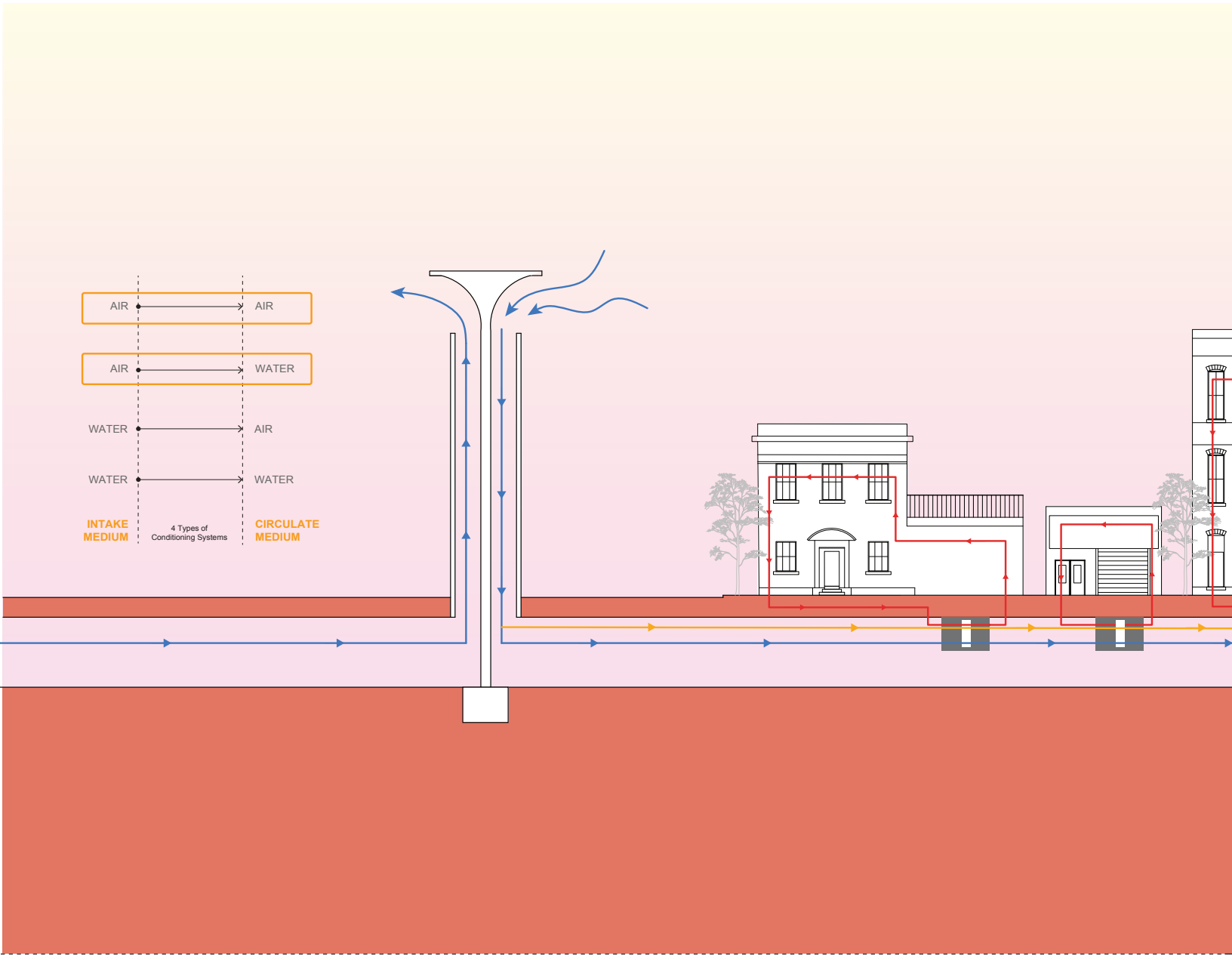
PROGRAMMING PHASES

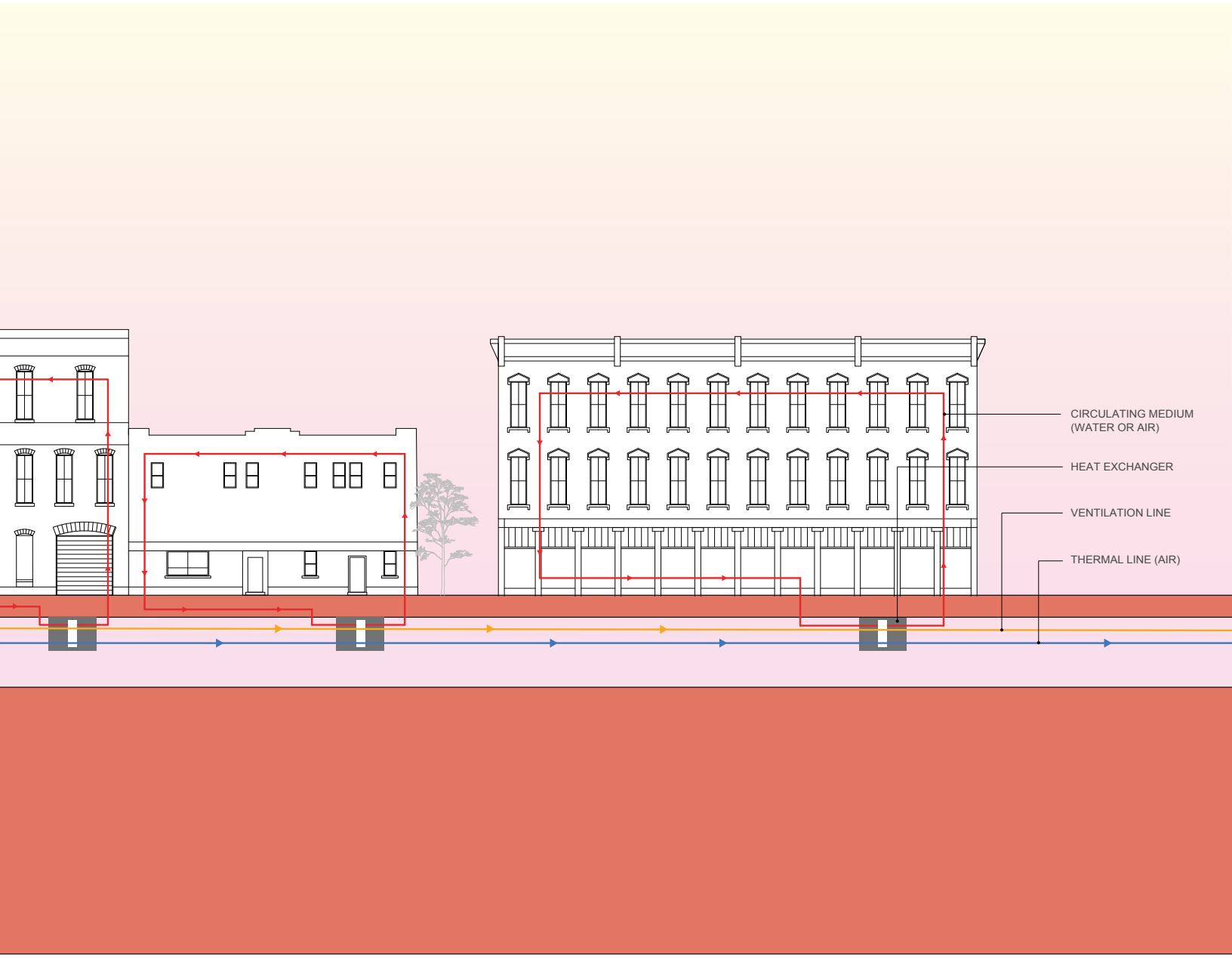
1. Working with existing context to increase energy efficiency
2. Adding new program / design to further integrate communities



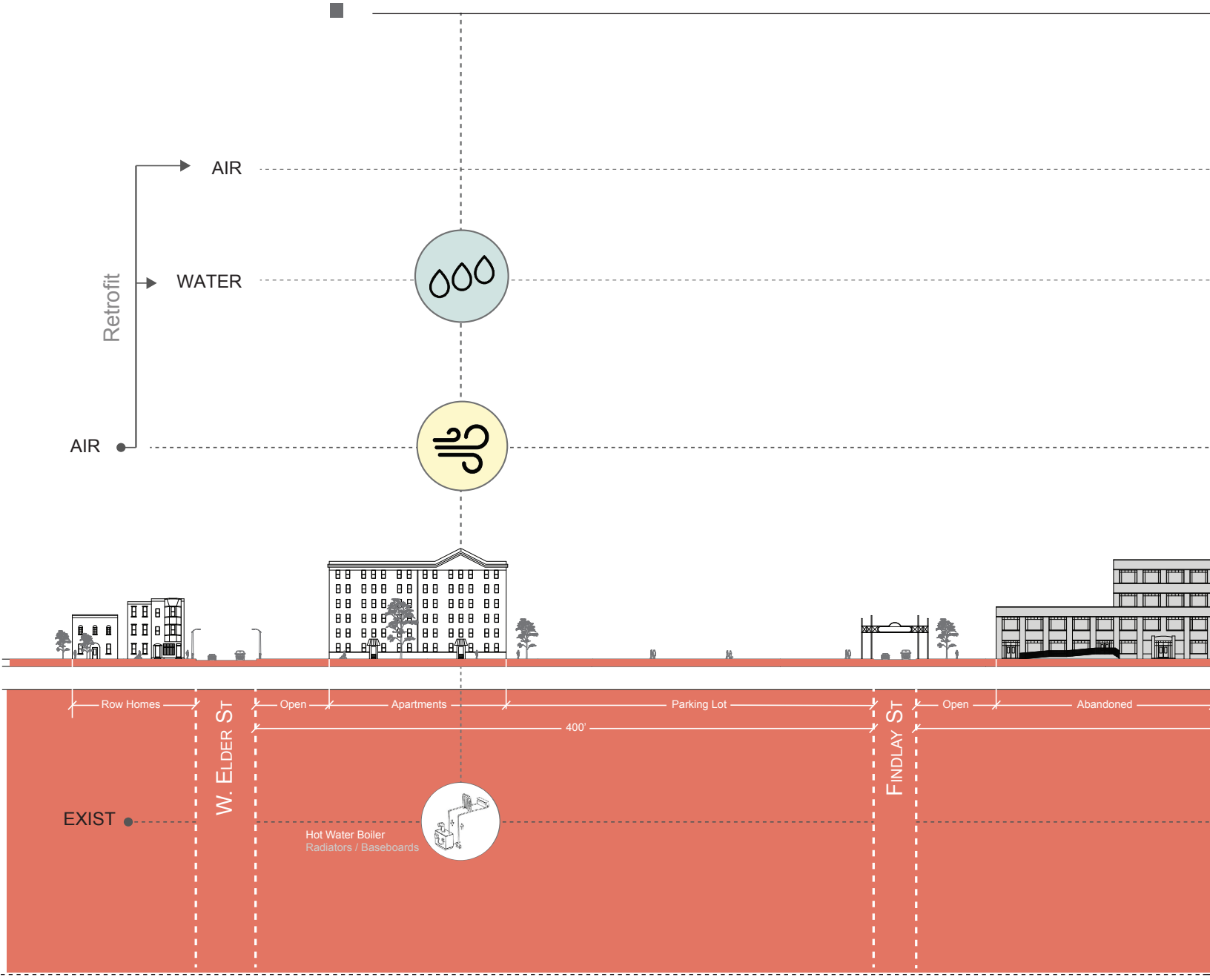


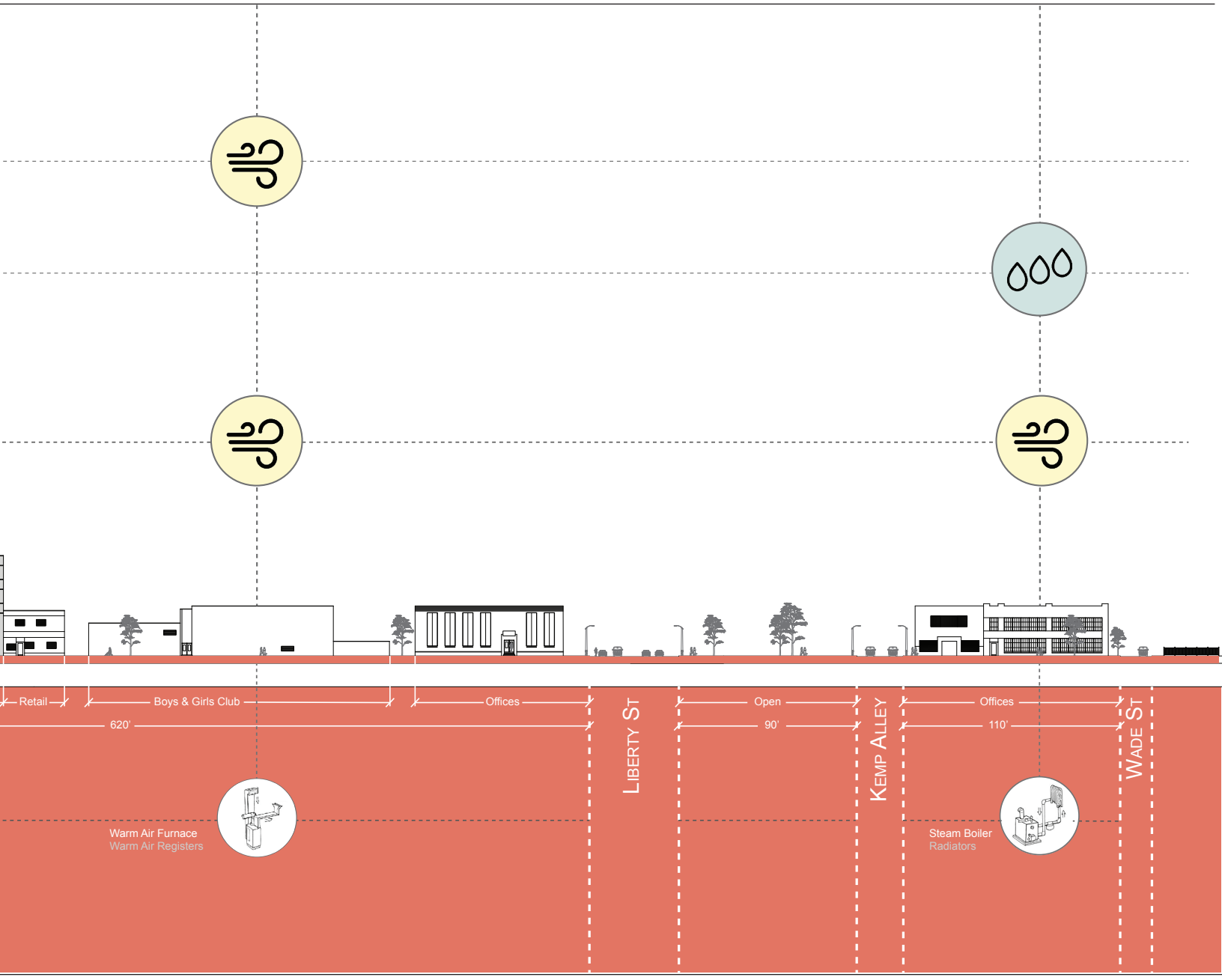
PROGRAMMING | phase one system



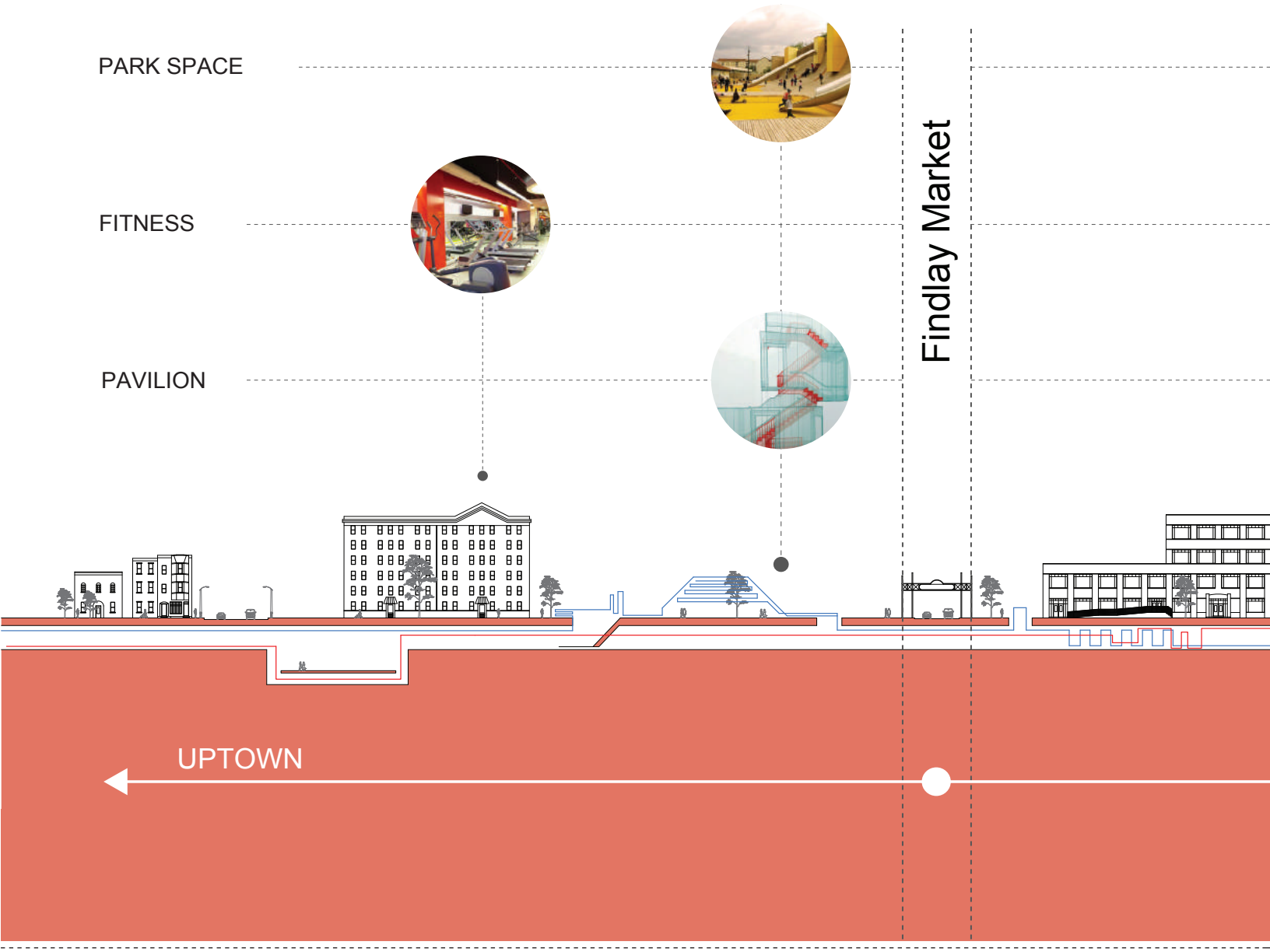

CIRCULATING MEDIUM
(WATER OR AIR)
HEAT EXCHANGER
VENTILATION LINE
THERMAL LINE (AIR)

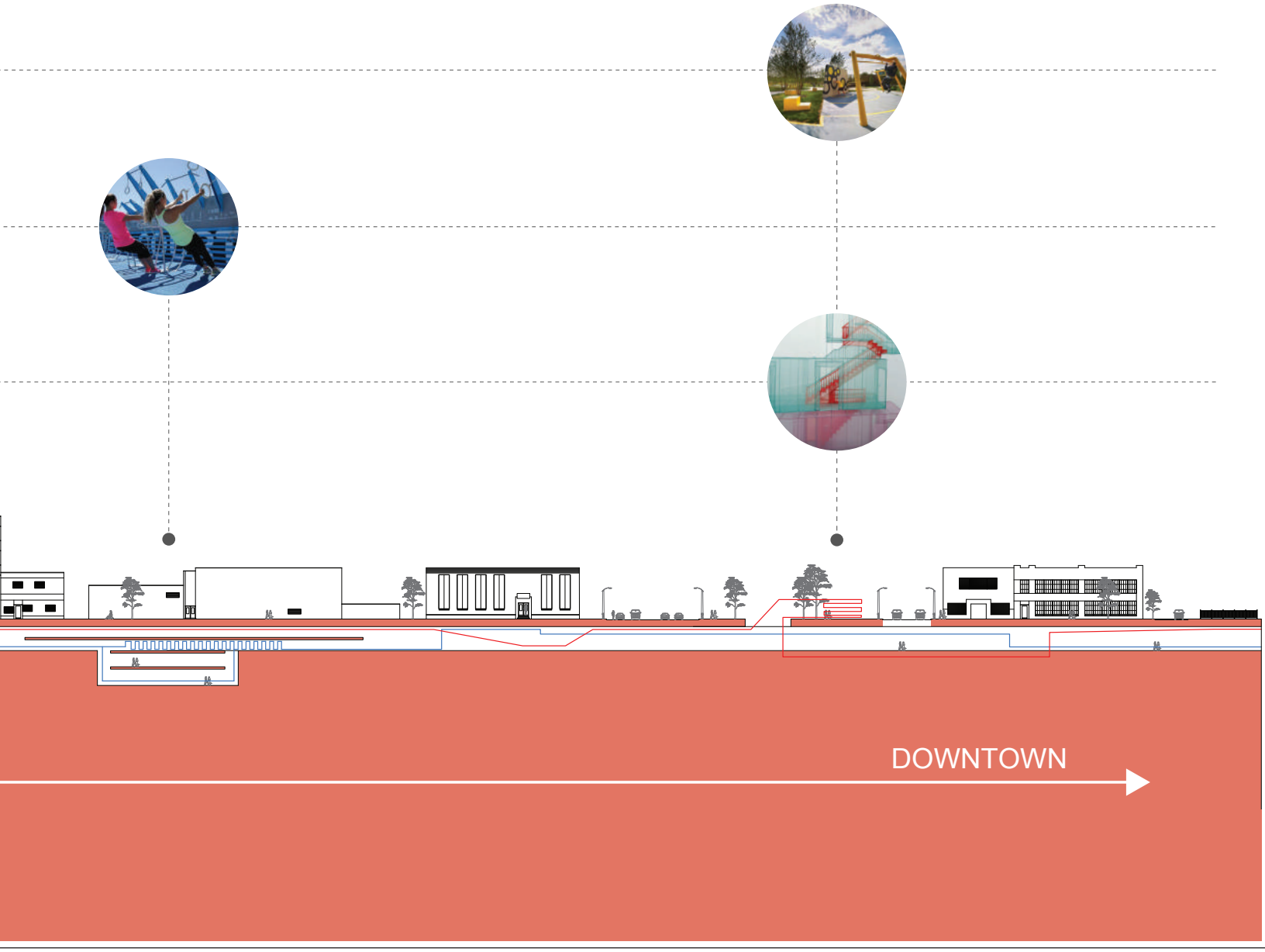
PROGRAMMING | phase one retrofit




Retail
Boys & Girls Club
Offices
620'
Liberty St
Open
90'
Kemp Alley
Offices
110'
Wade St
Warm Air Furnace
Warm Air Registers
Steam Boiler
Radiators

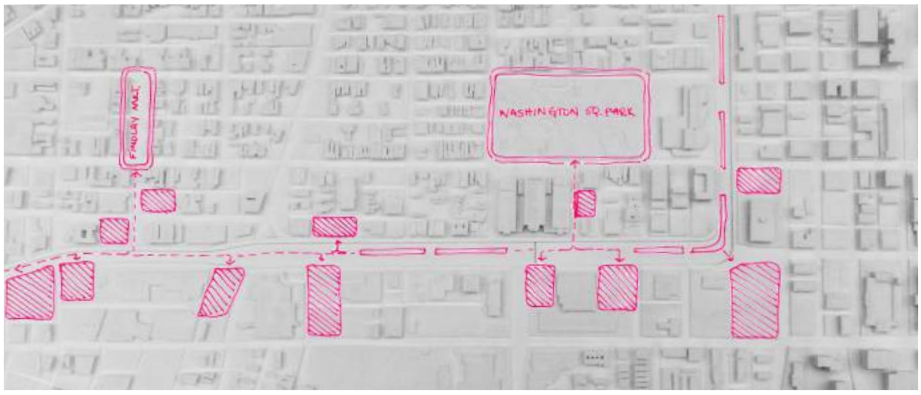
PROGRAMMING | phase two

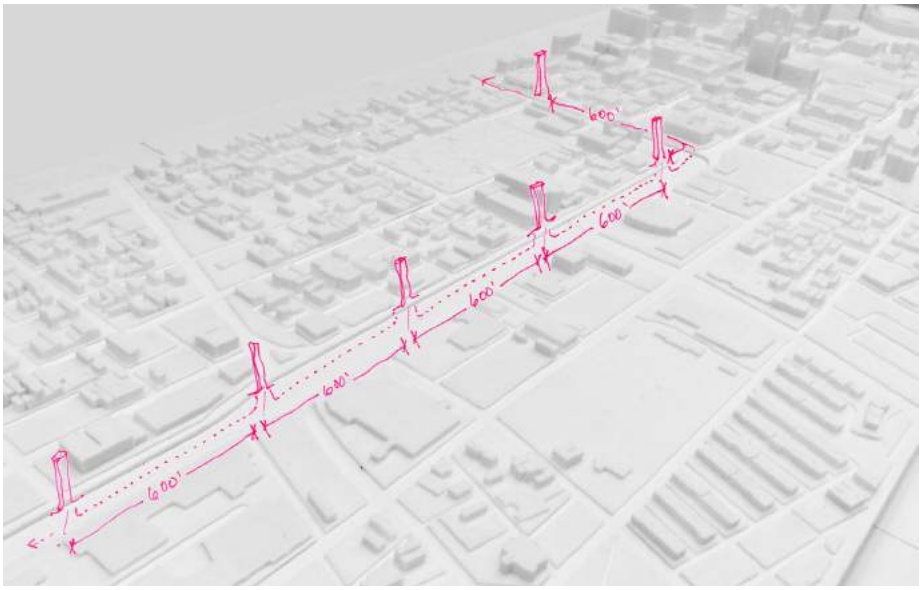


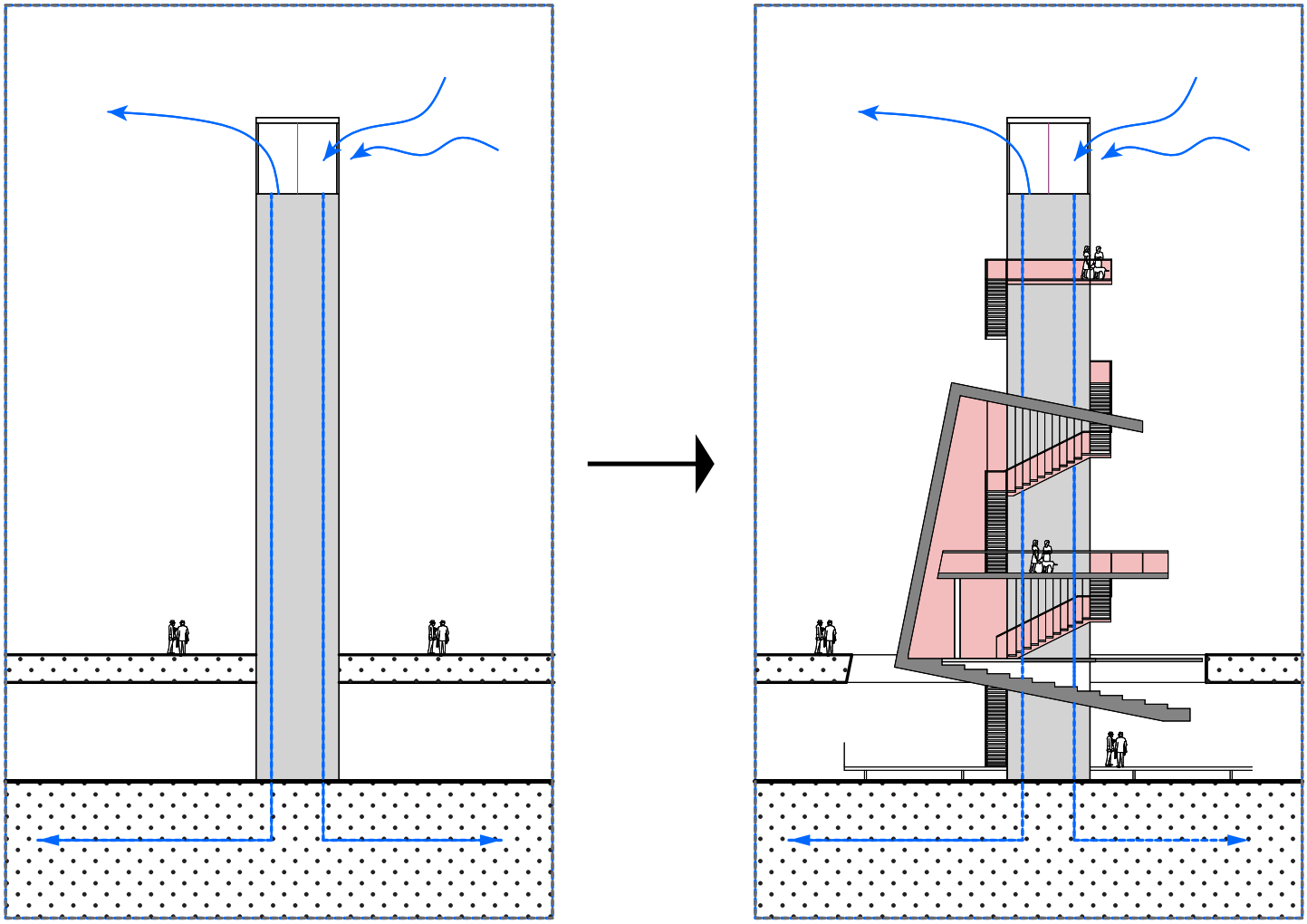

DOWNTOWN

WIND TOWER| access points

To situate each pavilion along central parkway there is a module of about 600 feet broken up by each wind tower. The wind towers act as vertical circulation points that bring both wind and people down in to the tunnel. A network of empty lots was mapped out between Findlay Market and Washington Square Park, two very active but disconnected pieces of the city. The wind towers / pavilions follow this line alternating on each side of the Parkway to create connections both on the north/south and east/ west axis.







GESTALT THEORY

To help peak the curiosity of people passing by as to what's below their feet, there was an idea of designing the pavilions as a landscape of buried objects. Gestalt theory was a great reference for this -- when you have a familiar shape that is cut off, the mind is still able to recognize and complete the shape even though part of it is missing. This concept was the foundation to the form of each pavilion. Four primary shapes were chosen -- a circle, a square, a house, and a triangle.

Parc de la Villette Sculpture
Samuel Molloy 5-6

Apocalyptic Dioramas
Thomas Doyle 4

Land Art
Cornelia Konrads 3

Sculpture to nowhere
Marc Elsey 1-2

2.

1.

5.

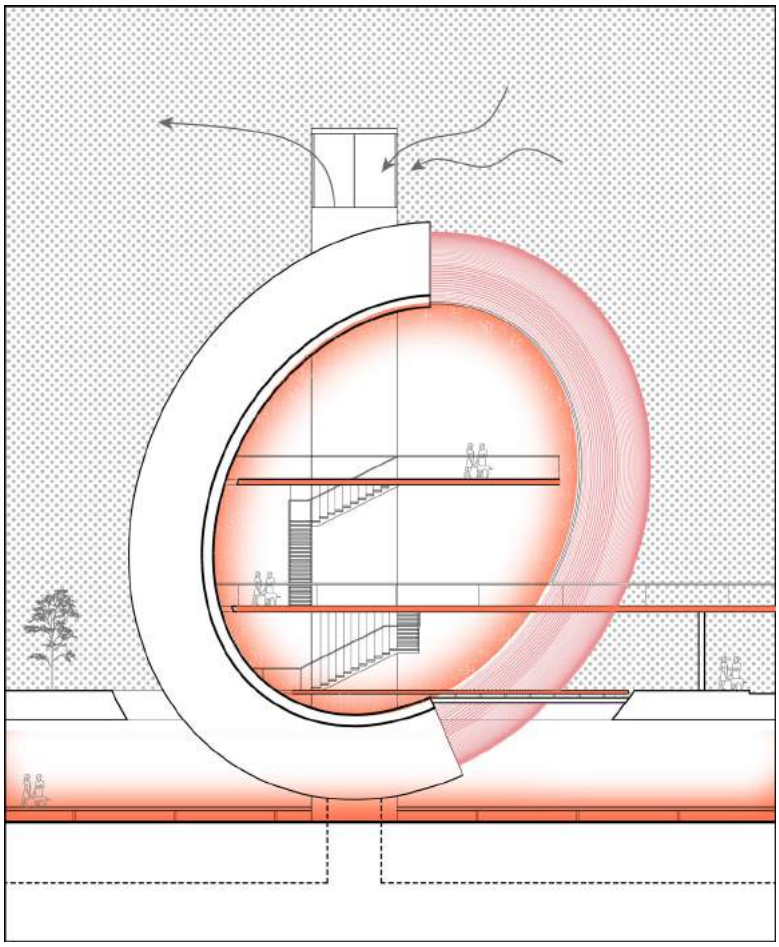
6.

3.

4.

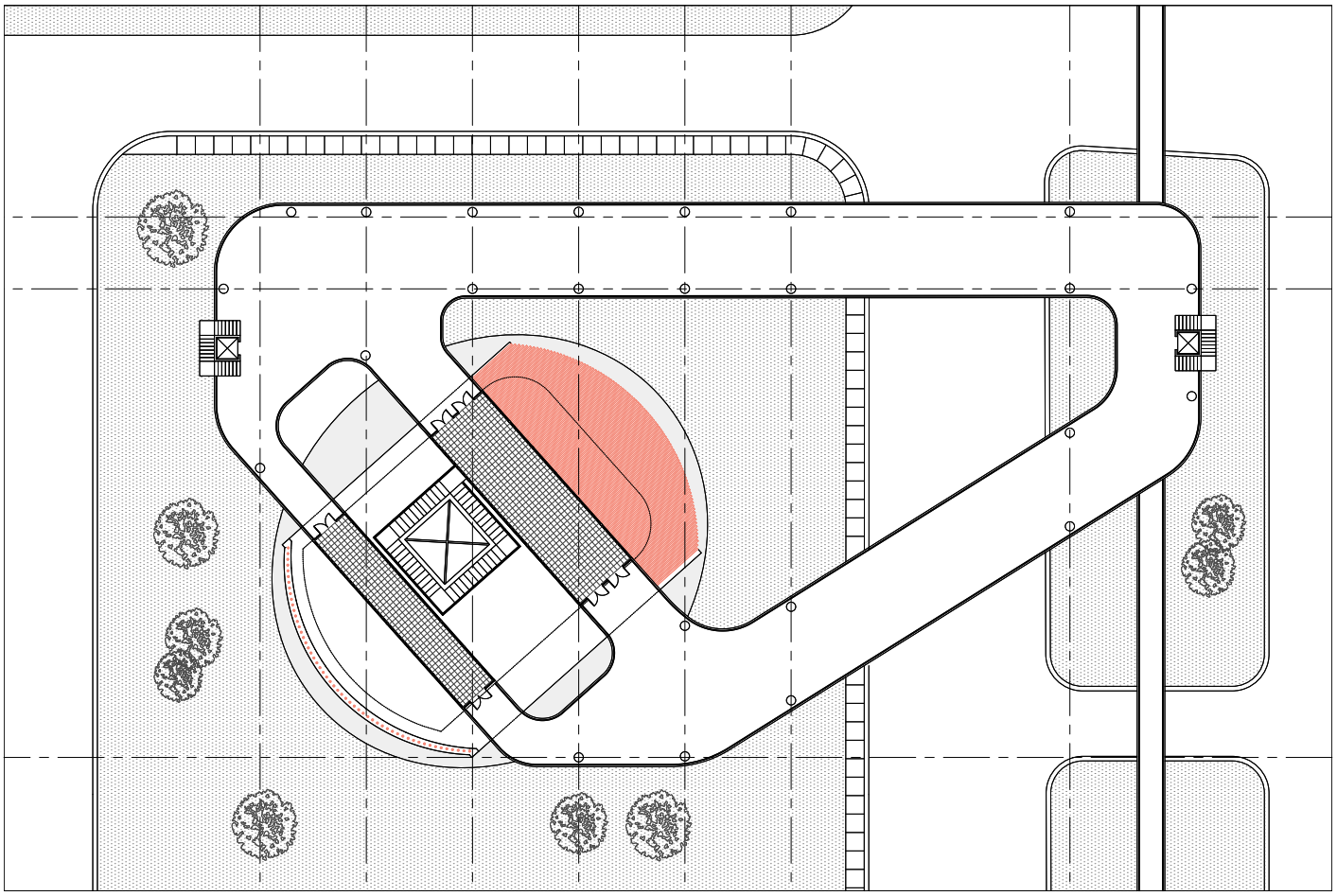
PAVILION | circle

Information Pavilion: *Tunnel History and Geothermal System info*



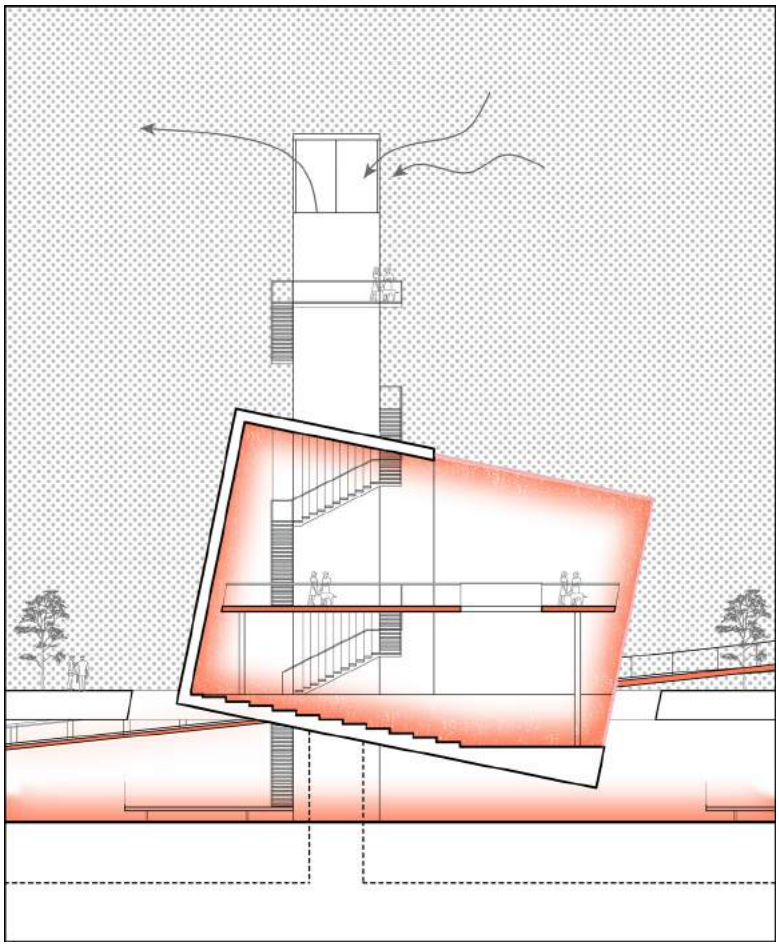
Section : Showing circle pavilion with exposed geothermal pipes and thermal atmospheres within each space

Plan : Showing circle Pavilion and catwalk bridging over to the median of Central Parkway



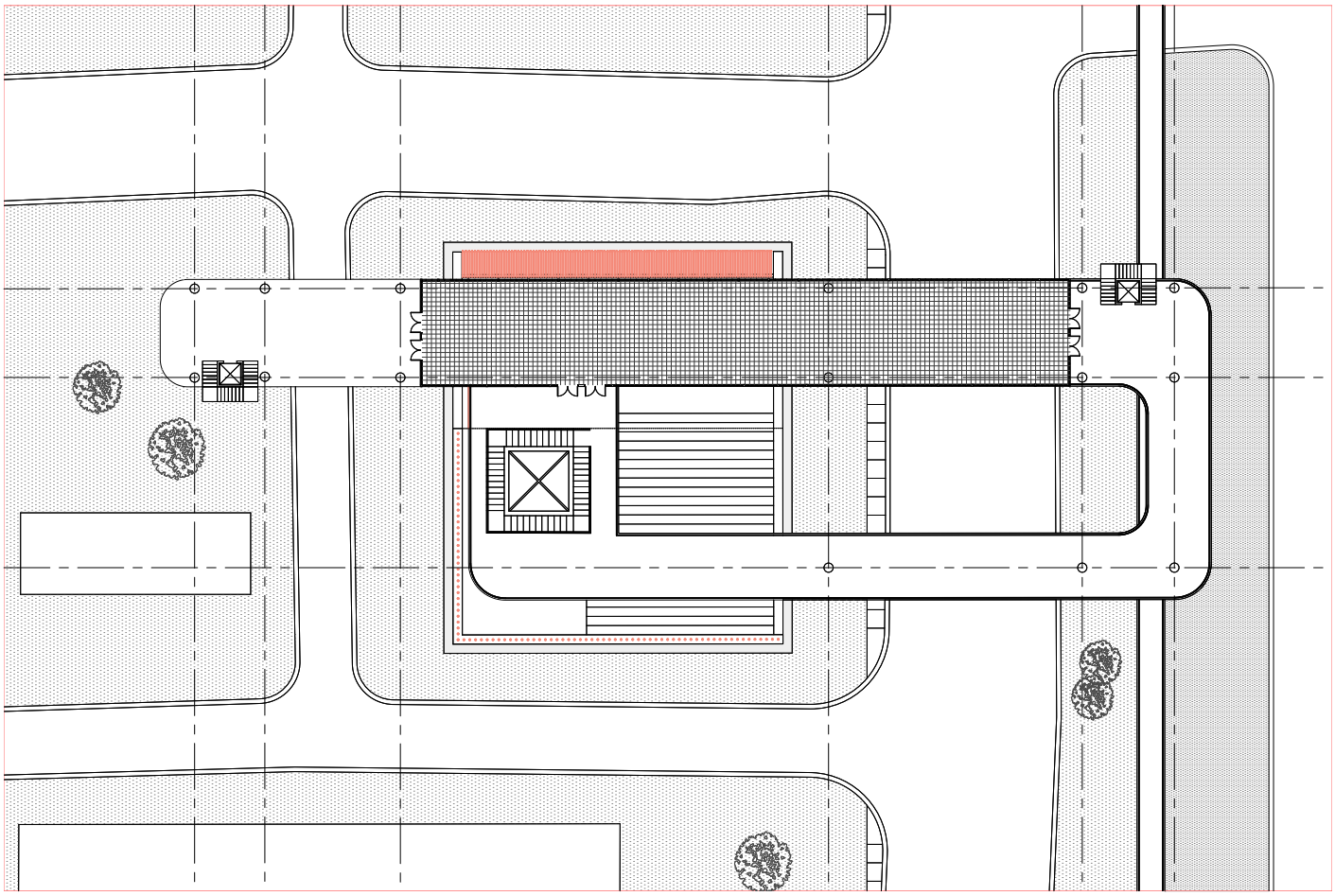
PAVILION | square

Public Event Pavilion:
Open Air Ampitheater



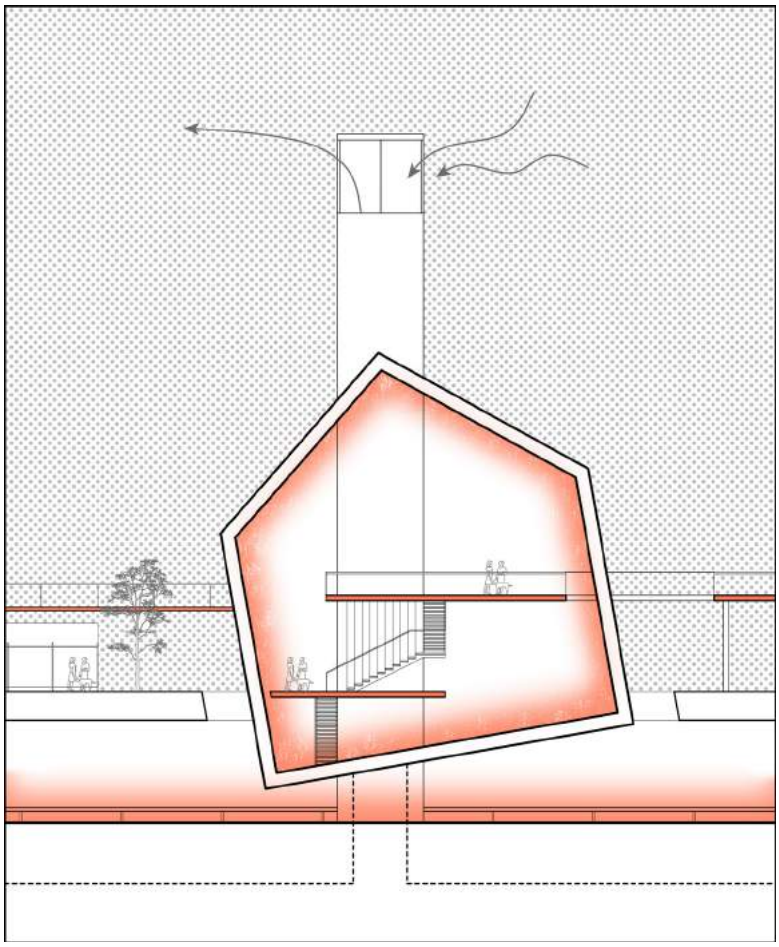
Section : Showing pavilion with exposed geothermal pipes and thermal atmospheres within each space

Plan : Showing Pavilion and catwalk bridging over to the median of Central Parkway



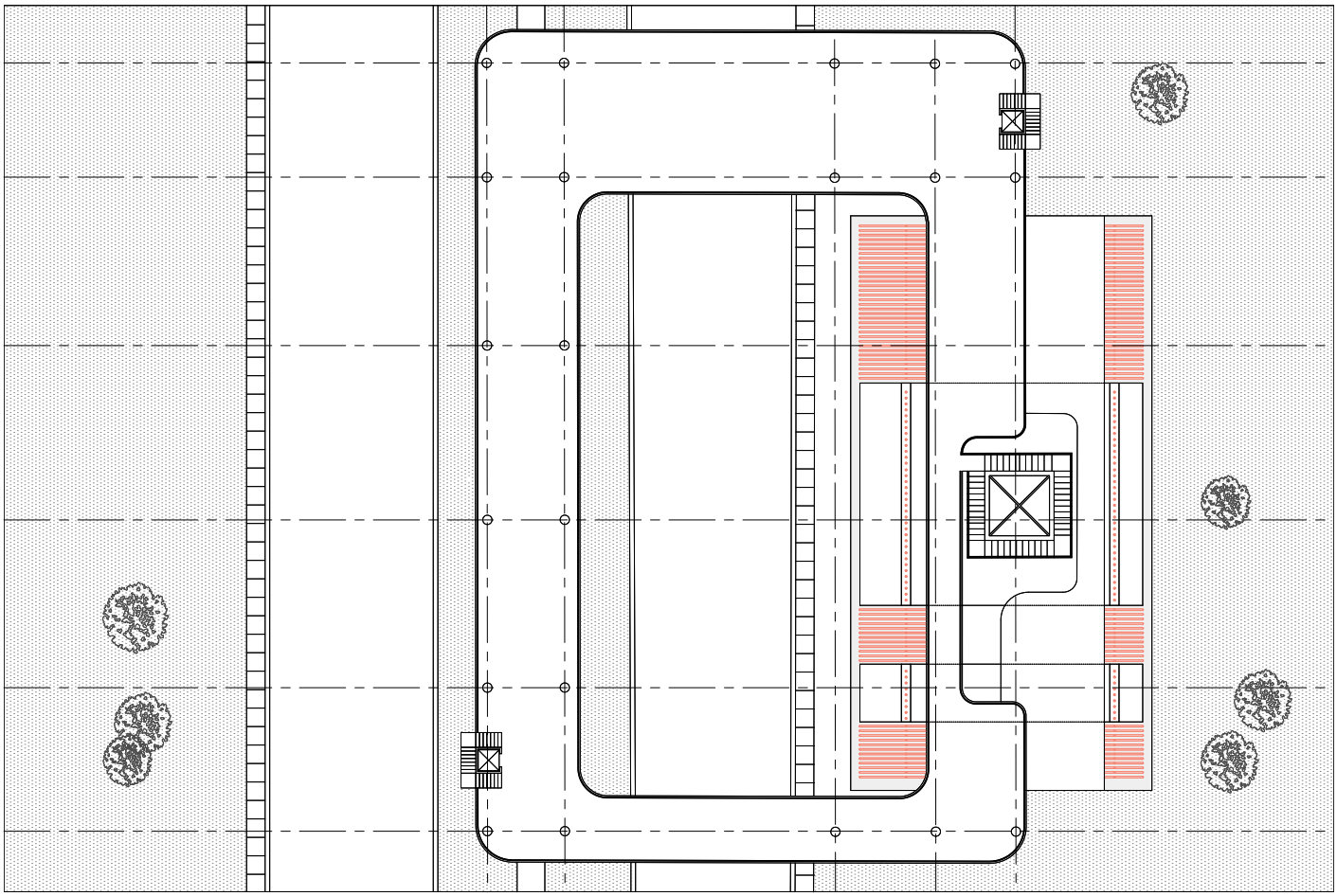
PAVILION | house

Commercial Pavilion:
Farmers Market



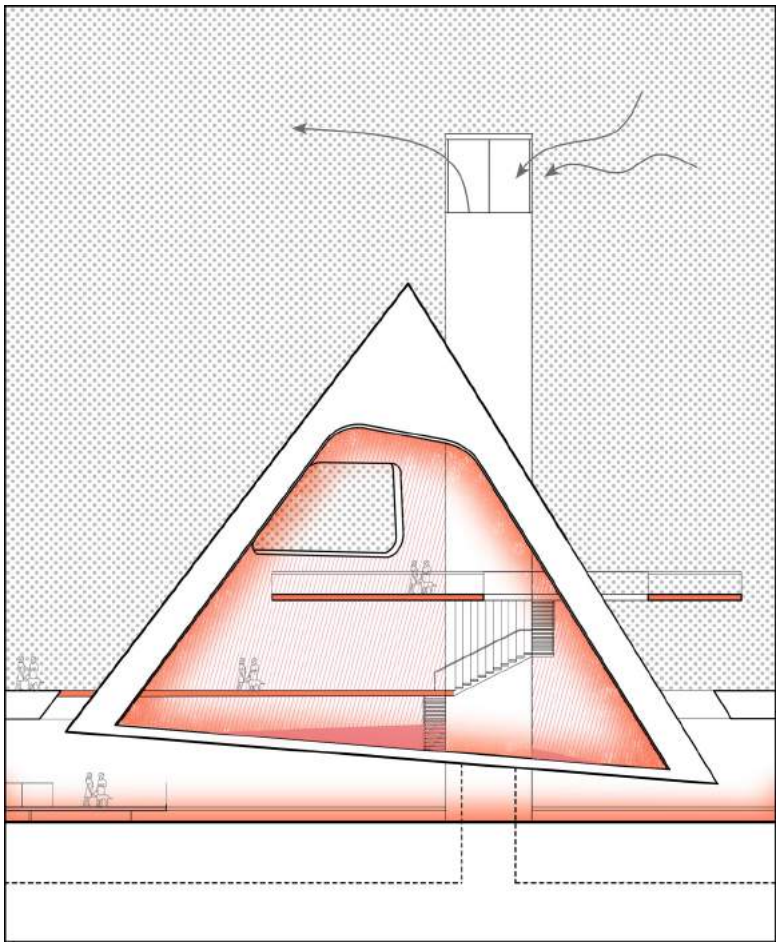
Section : Showing pavilion with exposed geothermal pipes and thermal atmospheres within each space

Plan : Showing Pavilion and catwalk bridging over to the median of Central Parkway



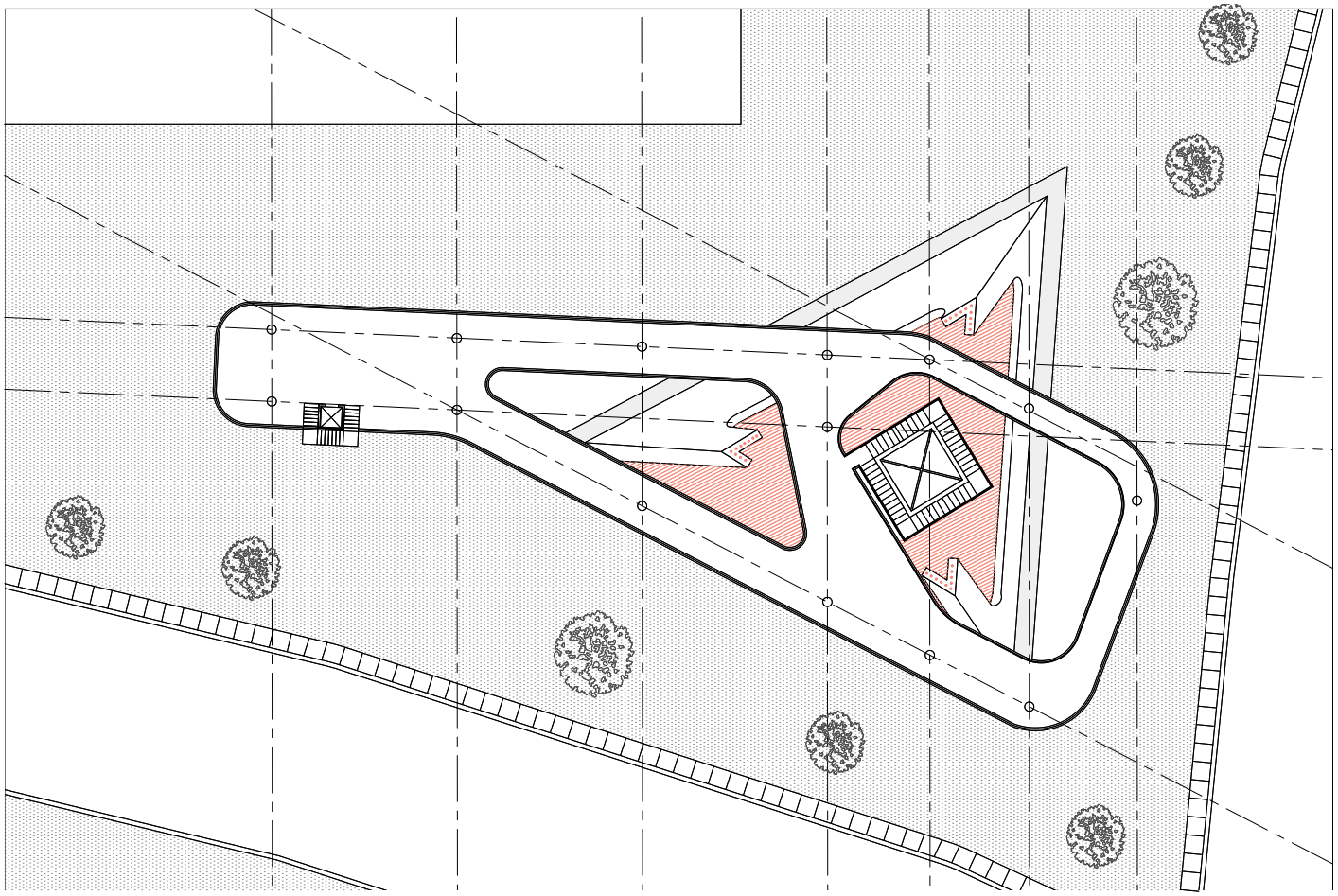
PAVILION | triangle

Transportation Pavilion:
Public Transport Waiting Area

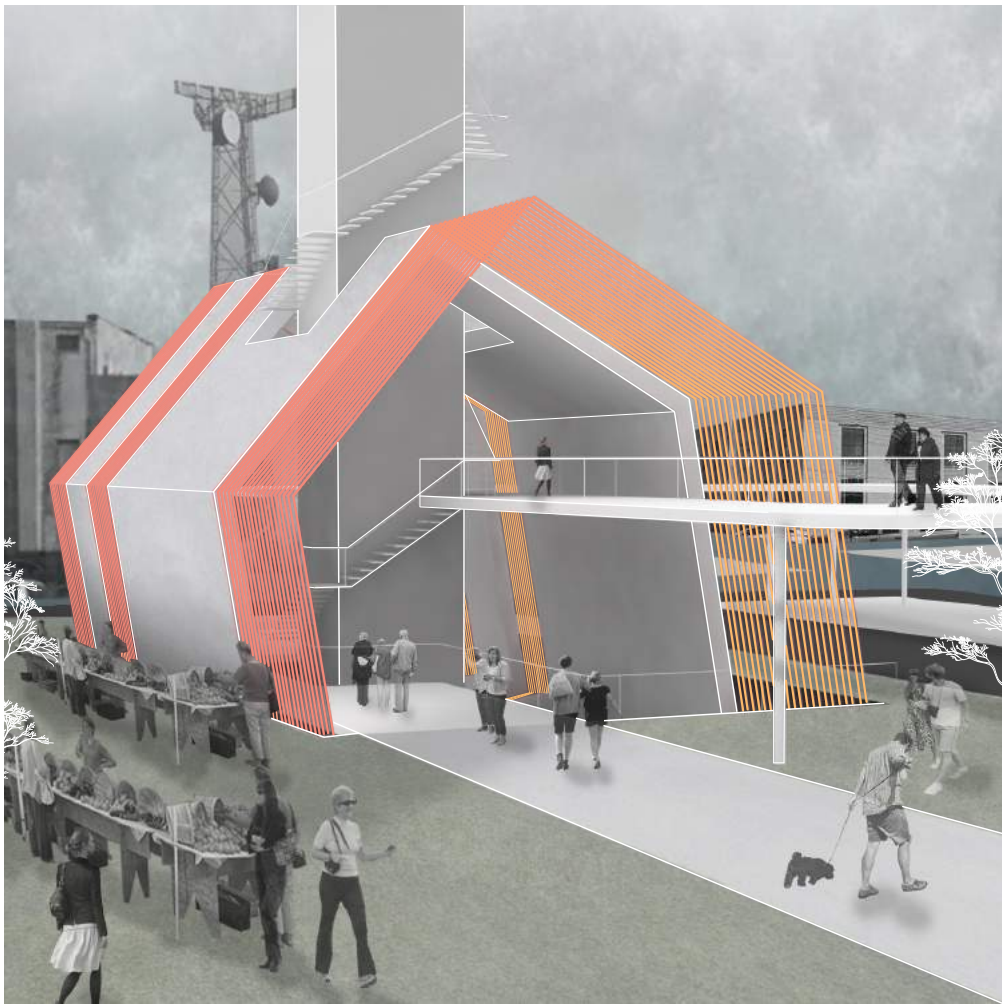


Section : Showing circle pavilion with exposed geothermal pipes and thermal atmospheres within each space

Plan : Showing circle Pavilion and catwalk bridging over to the median of Central Parkway



RENDERS

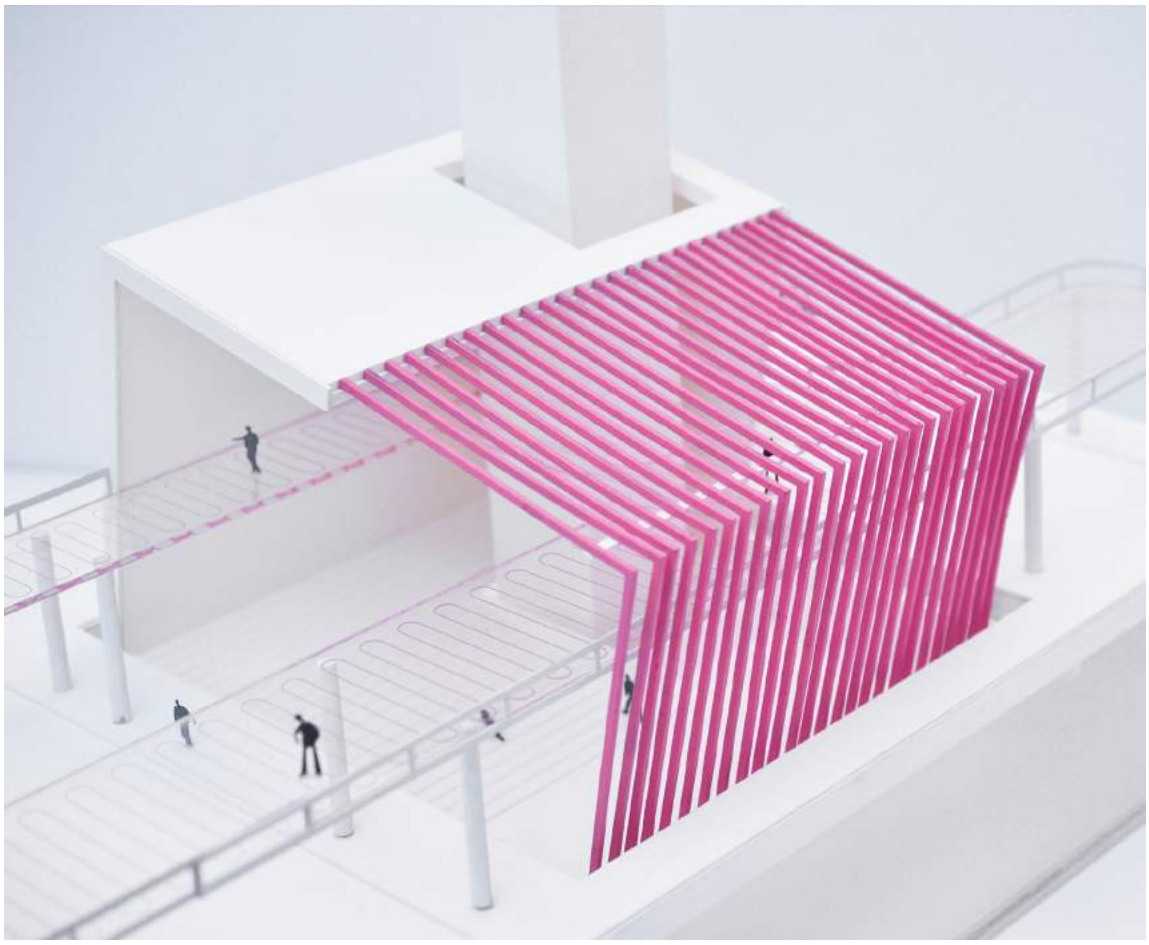


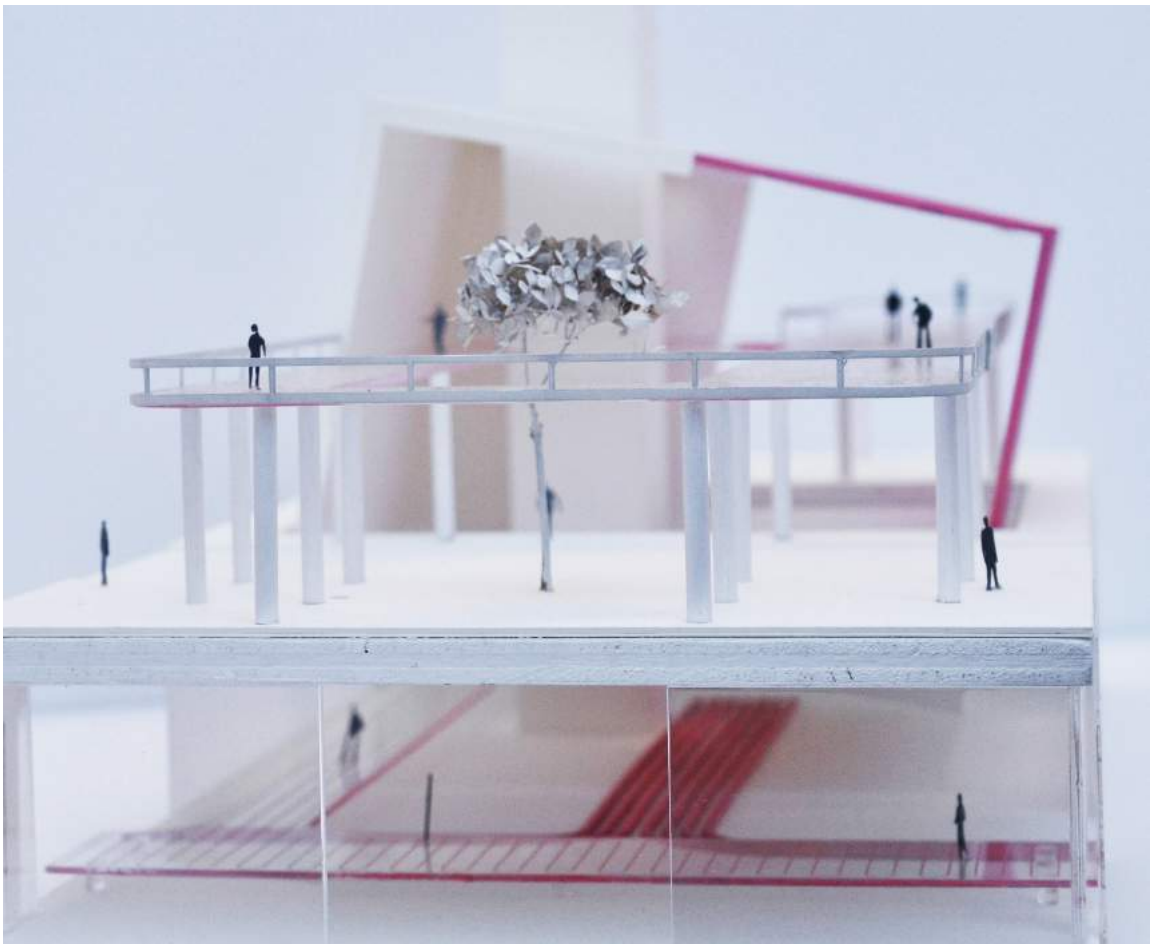
RENDERS

5

MODELS.

THE SQUARE

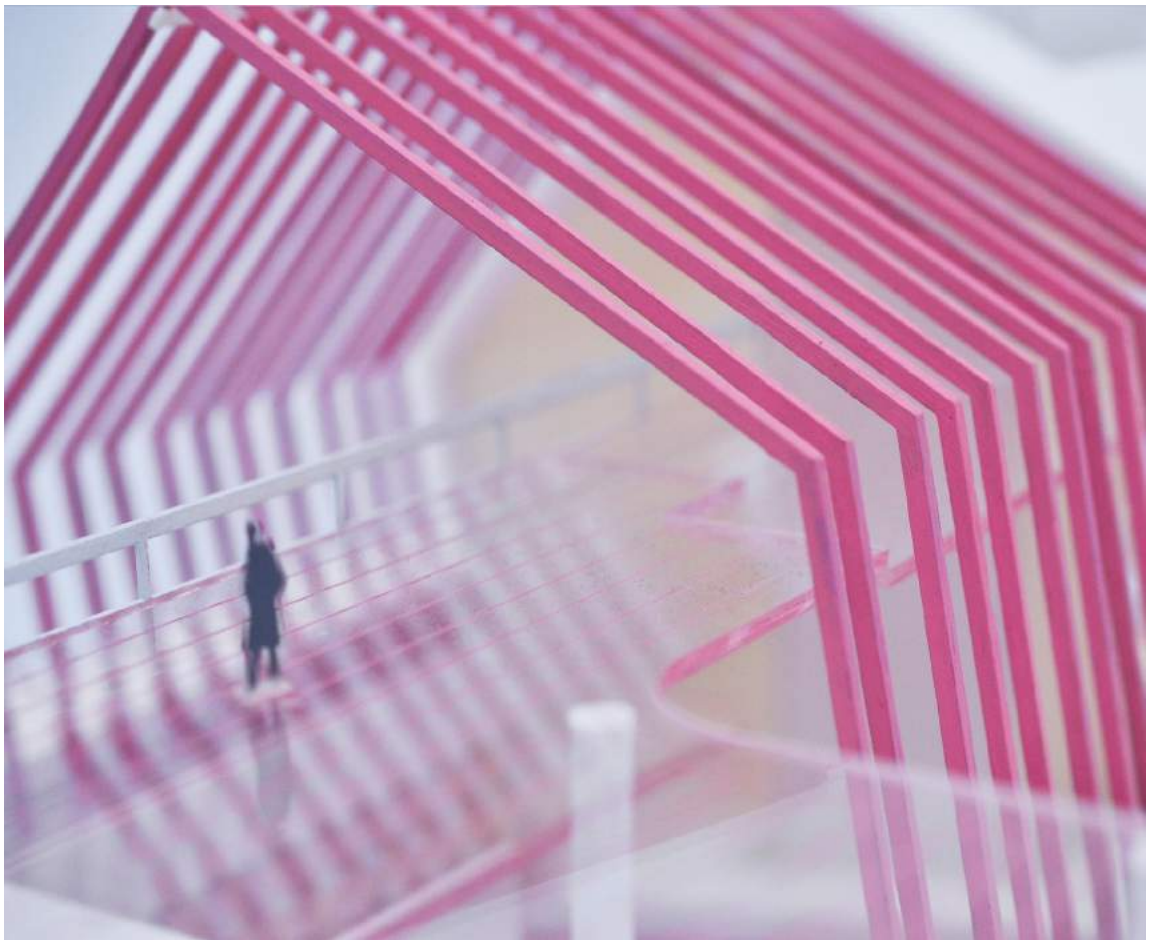




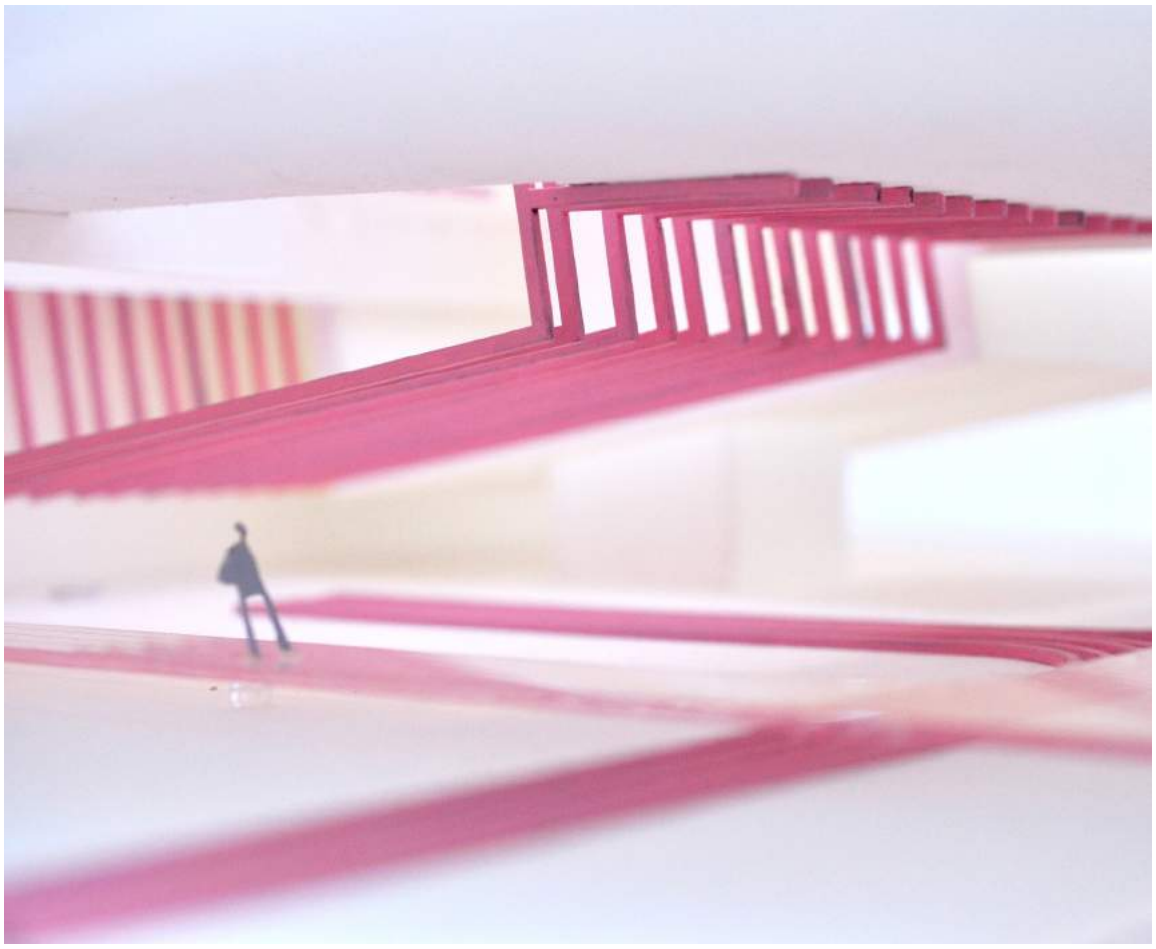
THE SQUARE

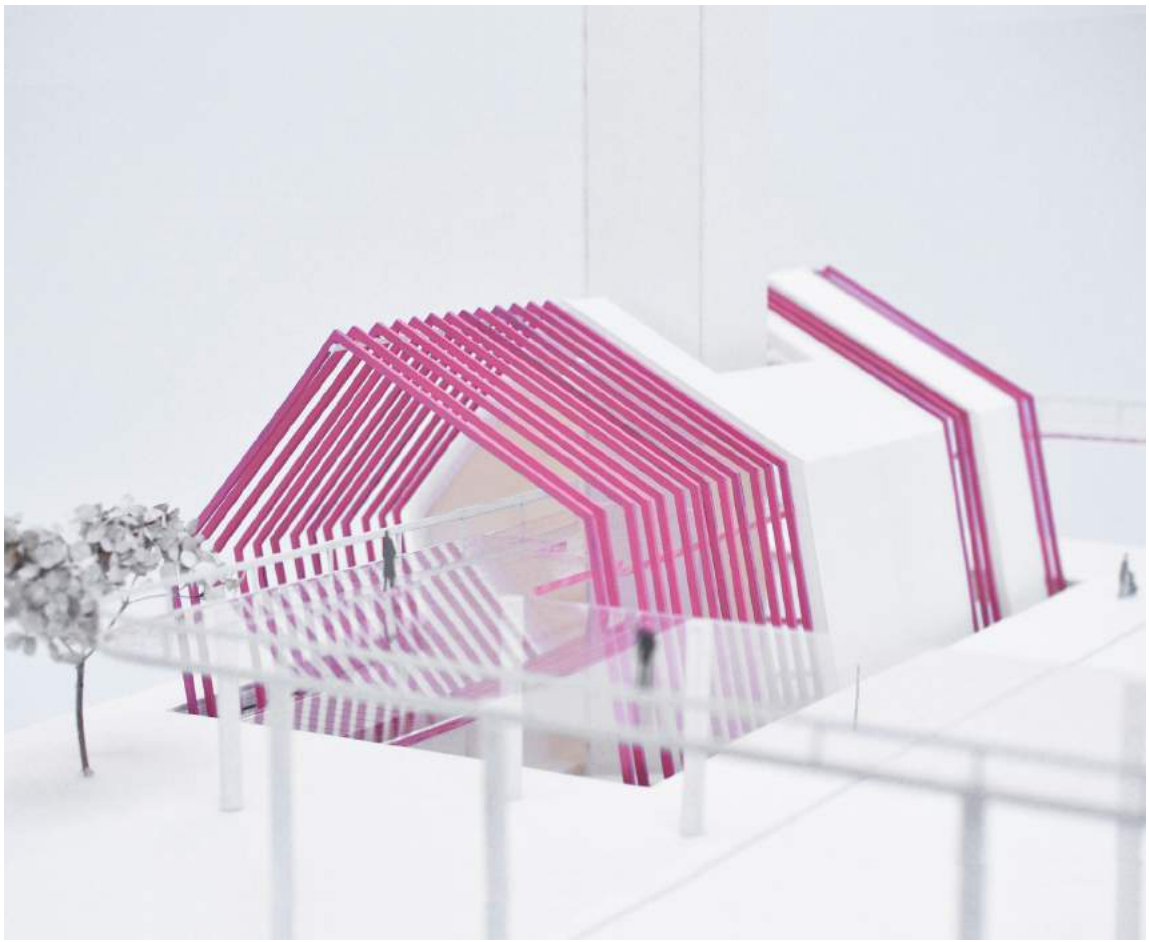
THE CIRCLE

THE HOUSE

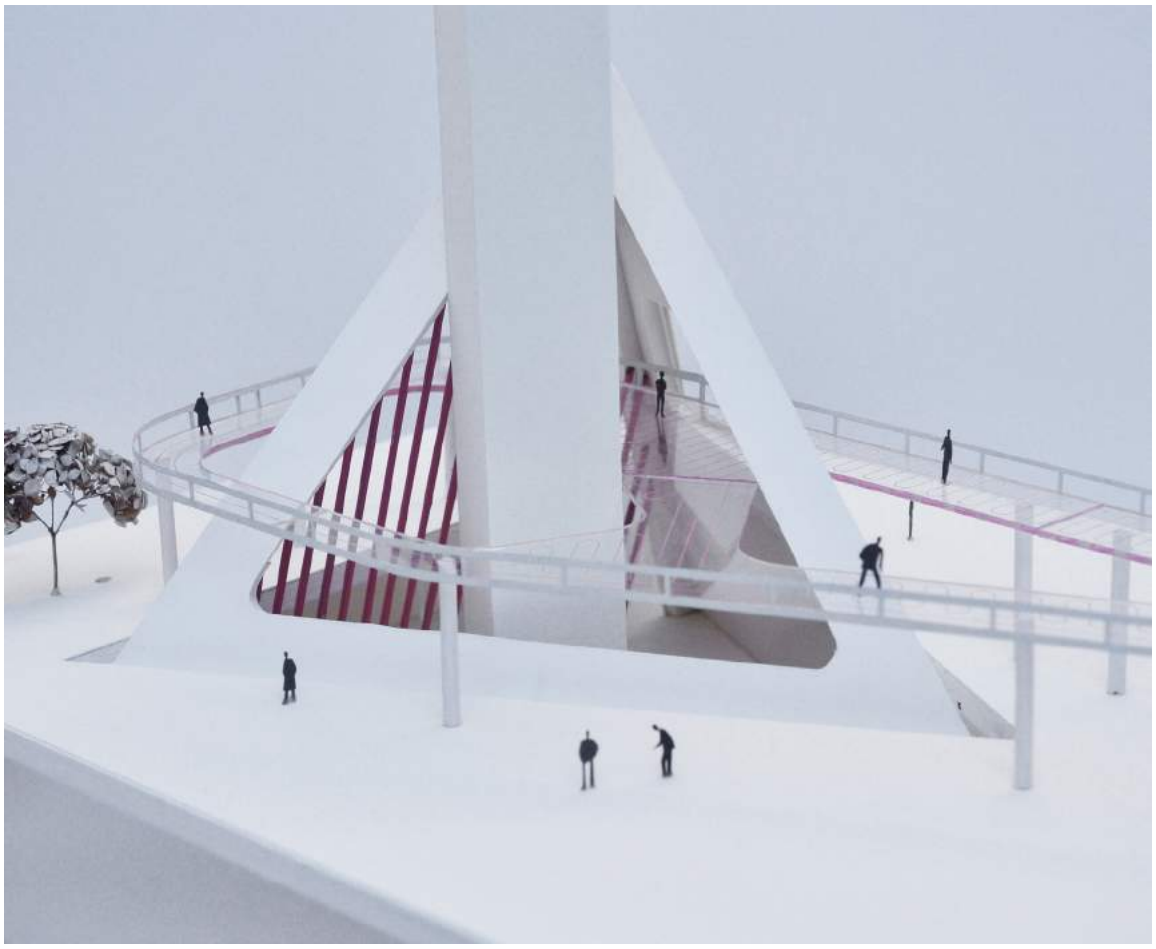


THE HOUSE





THE TRIANGLE



CONCLUSION

As said in the opening pages of this document, there are a million and one ways for us to waste something in this society. Everything you ever wanted could just be sitting off by the curb, just out of your periphery. It is our job as architects, and as a society to look around and recognize the potential of the forgotten. We don't always have to create and build anew. There could be something equally if not more exciting to be created from objects / forms / systems already in existence. Amazing, forgotten spaces can be found all over the world, and in the case of the Cincinnati tunnel, just 2 metres below your feet.

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thankyou

goodbye